ADDITIONAL DUWAMISH SEDIMENT OTHER AREA BACKFILL SAMPLING WORK PLAN

Duwamish Sediment Other Area and Southwest Bank

Corrective Measure and Habitat Project

Boeing Plant 2

Seattle/Tukwila, Washington

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Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

1.0 INTRODUCTION

The Boeing Company (Boeing) conducted sediment grab sampling of a portion of the completed adjacent Jorgensen backfill prior to conducting the dredging of the southern end of the Duwamish Sediment Other Area (DSOA). The backfilling in the Jorgensen area had been completed 1 to 2 months prior to the Boeing sampling. The results of this sampling indicated that, in the sample areas, there was significant deposition of fine-grained sediment (from a trace to approximately 5-centimeters [cm] thick) on the surface of the recently completed Jorgensen backfill. The concentrations of polychlorinated biphenyls (PCBs) ranged from 13.1 to 800 micrograms per kilogram (µg/kg) dry-weight parts per billion (ppb) with an average concentration of approximately 400 ppb. These data indicate that recontamination of the recently placed backfill occurred very rapidly; however, it is not known if this recontamination was due to depositional material from off-site sources or if the recontamination was from dredge residuals from Jorgensen's remedial action that were comingled during placement or redeposited on the surface of the backfill.

As part of Boeing's post-construction surface sediment monitoring program (AMEC et al. 2014), surface sediment samples within the DSOA were collected immediately after completion of the backfilling (Time 0 [T0]). T0 samples were collected at over 20 locations in the lower intertidal and subtidal portion of the DSOA within 1 month after completion of the backfill. At several of the locations, there appeared to be a thin film of fine-grained sediment present on the surface of the backfill.

At the two southern-most T0 sampling locations, the grab samples had a thicker layer of fine-grained material (0.5- to 3-cm thick) on the surface. These samples were collected within 3 weeks of the completion of the backfill. The accumulation of a thicker layer of depositional material at the southern-most locations may indicate that increased deposition is occurring and that the material is moving downriver from upriver sources.

The next scheduled sampling event detailed in the *Post-Construction Surface Sediment Monitoring Work Plan* (AMEC et al. 2014) is to be conducted one-year post-construction. Based on the deposition that was seen on the Jorgensen backfill and apparently at the southern-most portion of the DSOA, it is likely that a majority of the DSOA will have significant deposits of fine-grained material over the clean backfill surface at the next scheduled (Year 1) monitoring event. The work described in this plan will likely allow for a better understanding of the spatial and temporal dynamics of the deposition of fine-grained material on the surface of the DSOA backfill.

1.1 STUDY OBJECTIVE

The study objective is to understand the depositional patterns on a clean post-remedy surface in the Lower Duwamish Waterway. The approach to understanding the depositional patterns is to sample the surface of the Boeing Plant 2 DSOA backfill periodically prior to the next scheduled post-construction monitoring event (T=1, likely conducted in March of 2016). Sampling would be conducted monthly at the 30 locations shown on Figure 1 from April 2015 to February 2016.

At each location, a sample of the top 10 cm will be collected and the thickness of any deposited material will be determined. If sufficient fine-grained depositional material is present, a sample of the material will be collected. Selected top 10-cm samples will be analyzed for PCBs, total organic carbon (TOC), and total solids.

If samples of depositional material are collected, some may be analyzed for PCBs, TOC, and total solids. In addition, some samples may be analyzed for grain-size to determine the physical nature of the depositional material.

All work described in this plan will be conducted under the *Construction and Post-Construction Sediment Monitoring Quality Assurance Project Plan* (QAPP; Appendix A) developed for the Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project (AMEC et al. 2013).

1.2 SAMPLE LOCATIONS AND FREQUENCY

Sampling would be conducted monthly at the 30 locations shown on Figure 1 and in Table 1 from April 2015 to February 2016. The location of sample stations is based on a judgmental sampling design. The locations at the northern and southern end of the DSOA (i.e., Transects S1 through S5 and S11 through S15, respectively) were located to determine if deposition is predominately occurring from upstream sediment transport processes (Transects S1 through S5) or from downstream transport processes (Transects S11 through S15). Sample locations on Transects S6 through S10 would be used, in conjunction with the other transects, to determine if deposition of fine-grained material is more widely distributed and potentially not dominated by either upstream or downstream transport.

Several of the proposed sampling locations for this study are located in the vicinity of the samples collected as part of the annual post-construction surface monitoring program (see Figure 1). The additional samples collected during this study will provide additional information on any short-term changes in the physical and chemical properties of the adjacent post-construction surface monitoring stations.

Depending on the depositional rate and distribution of deposited material, sample locations and the frequency of sampling may be changed (e.g., if little deposition of material is noted for 2 successive months then the frequency of sampling could be reduced to once every two months). Any changes to sample locations and/or sampling frequency will be coordinated with EPA.

1.3 ANALYTES

Selected samples from each monitoring event will be analyzed for PCBs (measured as Aroclors), TOC, total solids, and grain size. Analytical data will meet the project data quality objectives (DQOs) provided in the QAPP (Appendix A). The specific target reporting limits for the analytes are presented in Table 2. Table 2 also presents the minimum sample size and holding times.

Any samples not analyzed from each round of sampling will be archived for potential future analysis.

2.0 GRAB SAMPLING METHODS

Sediment samples will be collected using a sediment grab sampler (i.e., 0.1-square-meter [m^2] stainless-steel van Veen sampler or 0.2-m^2 stainless-steel powered grab sampler. Samples will be collected within approximately 3 meters (m; approximately 10 feet) of the proposed sample location. Surface sediments to a depth of 10 cm (approximately 4 inches) will be collected. Sediments touching the sides of the grab sampler will not be collected or included in the homogenized samples. The sampler will be decontaminated at the beginning of each sampling day in accordance with the procedures in Section 2.1. The grab sampler will be rinsed to remove any adhering sediment between each sampling location since no sediment will be collected for analysis that is in contact with the grab sampler.

2.1 EQUIPMENT DECONTAMINATION

Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment sample material must meet high standards of cleanliness. Sample containers will be provided by Analytical Resources, Inc., and are pre-cleaned, certified, and individually labeled with a lot number traceable to a Certificate of Analysis.

All sediment-handling equipment will be cleaned and decontaminated prior to arrival at the site. All equipment and instruments used to remove sediment from the sampler will be disposable stainless steel and will be decontaminated prior to arrival at the site. The Amec Foster Wheeler standard decontamination procedure for the grab sampler and other sample handling equipment is modeled after Puget Sound Estuary Program (PSEP) protocols (PSEP 1997); however, the decontamination procedure will not use any acid or solvent rinses (the final rinse will use distilled water). The decontamination procedure is as follows:

1. Prewash rinse with tap water.
2. First wash with solution of tap water and Alconox soap (brush).
3. Second rinse with tap water.
4. Second wash with solution of tap water and Alconox soap (brush).
5. Final rinse with tap water.
6. Final rinse with distilled water.
7. Wrap all decontaminated items with aluminum foil.
8. Storage in clean, closed container prior to use.

2.2 Sample Acceptability

The following acceptability criteria for the grab samples should be satisfied:

- The sampler is not overfilled with the sample such that the sediment surface is pressed against the top of the sampler.
- Overlying water is present (indicates minimal leakage).
- The overlying water is not excessively turbid (clear water indicates minimal sample disturbance).
- The sediment surface is relatively flat (indicates minimal disturbance or winnowing).
- The penetration depth is at least 15 cm for a 10-cm-deep surficial sample.

If a sample does not meet any one of these criteria, it will be rejected.

2.3 Sample Processing

Overlying water is slowly siphoned off near one side of the grab sampler with a minimum of sample disturbance. Sample material that is, or has been, in direct contact with the grab sampler will not be included in the sample volume.

The exposed sediment surface of the grab will be photo-documented using still photos. A qualified field geologist will log each grab for Universal Soil Classification and note the presence of any soil structures, odors, or visible oil sheens on the qualitative sample characteristics form. Depth of grab sampler penetration, surface winnowing, or other disturbance will be noted. Surface and subsurface sediment descriptions and the in situ depths of each identified sediment horizon will be recorded. The thickness of any measureable fine-grained depositional material will determined using a stainless-steel ruler. The ruler will be inserted into the sediment until resistance from the underlying sand backfill material is felt and the thickness will be recorded. The thickness of the depositional material will be measured at three locations in the grab where the sediment appear to be undisturbed. In addition, an attempt will be made to remove a portion of the sediment in the grab sampler to expose a section view of the collected sediment for a photograph.

Sediments will be collected from the center of the grab sampler to a depth of 10 cm. Sediment touching the sides of the grab sampler will not be placed in the sample container. A minimum of 500 milliliters of sediment is needed for all the required analyses. Approximately 1 liter of sediment will be collected if available. The sediment will be removed from the grab and placed directly into 1-liter glass jars; the sediment will be homogenized by the analytical laboratory prior to analysis.

2.4 SAMPLE IDENTIFICATION

All samples will be assigned a unique identification code. This hyphenated alphanumeric code consists of a media code (i.e., SD for sediment), monitoring type (i.e., DM for deposition monitoring), transect identification (i.e., S1 to S15), a location identifier (i.e., 1 or 2), and a (month/year) code (e.g., SD-DMS1-2-0415 for sediment sample collected from transect 1, sample location 2, and collected in April 2015). Each sample jar will be labeled with the sample identification code, the company name, project code, the initials of the sampler, the date and collection time and the analysis to be conducted. The label on each jar will be covered with stretch wrap to prevent loss or damage.

2.5 SAMPLE HANDLING AND CUSTODY

Grab samples will be processed as soon as they are collected. Sediment samples will be kept in sight of the sampling crew or in a secure, locked vehicle at all times. Samples will be transported directly to the laboratory or to the Amec Foster Wheeler office at the end of the day for storage (samples will be placed in coolers with "blue ice" or frozen) until transferred to the testing laboratories. Transfer of samples from Amec Foster Wheeler custody to the laboratory will be documented using chain-of-custody procedures. Coolers used to transport samples will be sealed with a Custody Seal before shipping if not hand delivered by Amec Foster Wheeler to the analytical laboratory.

Surplus sample material will be archived and stored at the analytical laboratory in a secure area. Storage requirements for all archived samples will include freezing and storage of the samples in a temperature-monitored freezer at 18°C.

2.6 FIELD QUALITY CONTROL REQUIREMENTS

Prior to each daily sampling event, the differential global positioning system (DGPS) will be tested for accuracy. A checkpoint accessible to the field crew will be occupied. At the DGPS checkpoint, the DGPS unit will be stationed and a position reading will be taken. The DGPS position will be compared to the known checkpoint coordinates. The DGPS position readings should agree to within 1 to 2 m of the known checkpoint coordinates. If the position readings do not agree within 1 to 2 m, the DGPS unit will be carefully checked and electronics reset. After checking and resetting the DGPS, if the positions still do not agree, other actions may be taken including replacing the unit.

Decontamination (rinsate) blanks will not be collected from the grab sampler since sediments touching the side of the sampler will not be collected. Rinsate blanks will not be collected from the utensils used to remove sediments from the grab since the utensils are disposable and will not be reused.

Samples will be handled and transferred using the standard chain-of-custody procedures. Data and log forms produced in the field will be reviewed daily by the person recording the data, so that any errors or omissions can be corrected. All completed data sheets are removed daily from the field clipboard and photocopied; the original data sheets are filed in a fireproof file cabinet and the photocopies stored in the project file. All data transcribed from field forms into electronic forms and tables will be 100 percent verified for accuracy and freedom from transcription errors.

The Field Manager will be responsible for ensuring that all supplies necessary to conduct the sampling, including collecting, processing, and transporting samples, are available and in good working order at the beginning of the fieldwork. The Field Manager will monitor supplies and equipment throughout sampling and replenish or replace as necessary.

The Field Manager will be responsible for correcting equipment malfunctions during the field sampling. In addition to equipment failures, conditions that require a modification of the intent of the sampling program will be coordinated with Boeing and the U.S. Environmental Protection Agency (EPA) by the Field Manager or the Consultant Team Project Manager. All response actions will be documented on field forms or in a logbook.

2.7 LABORATORY QUALITY CONTROL REQUIREMENTS

Laboratory quality control (QC) requirements include using standard EPA analytical methods, performing method-specified QC samples (such as including analysis method blanks, spikes, and surrogates), and meeting method-specified calibration and system performance criteria. These QC checks are detailed in the Sediment Monitoring QAPP (AMEC et al. 2013, Appendix A). Analyses will be carried out under the laboratory's Standard Operating Procedures (SOPs).

Analytical instruments will be calibrated according to the analytical methods specified in the laboratory SOPs. All analytes reported will be present in the initial and continuing calibrations, and these calibrations will meet the acceptance criteria specified in the QAPP (AMEC et al. 2013, Appendix A). Records of standard preparation and instrument calibration will be maintained, and calibration standards shall be traceable to standard materials.

Instrument calibration will be checked at the frequency specified in the method using materials prepared independently of the laboratory control samples (LCSs). Multipoint calibrations will contain the minimum number of calibration points specified in the method, with all points used for the calibration being contiguous. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed will be included in the initial calibration. The continuing calibration verification cannot be used as the LCS.

3.0 DOCUMENTATION AND RECORDS

Data and log forms produced in the field will be reviewed daily by the person recording the data so that any errors or omissions can be corrected. All completed data sheets are removed from the field clipboard and photocopied; the original data sheets are filed in a fireproof file cabinet and the photocopies stored in the project file. All data transcribed from field forms into electronic forms and tables will be 100 percent verified for accuracy and freedom from transcription errors.

Laboratory documentation will consist of a case narrative, providing descriptions of any problems and corrective actions, copies of the chain-of-custody forms, tabulated analytical results, data qualifiers, and blank and matrix-spike results with calculated percent recoveries and differences. A more detailed documentation package (raw data, analyst's reports, extraction logs, chromatograms, etc.) will be provided by the laboratory in case the Stage 2B summary data review (QAPP; AMEC et al. 2013, Appendix A) encounters deficiencies requiring more thorough laboratory documentation.

All project documentation records will be kept on file at the offices of Amec Foster Wheeler in Lynnwood, Washington. All field and laboratory data generated as part of this Work Plan will be retained at the offices of Amec Foster Wheeler and Boeing as specified in the Administrative Order on Consent.

4.0 DELIVERABLES AND SUBMITTALS

4.1 INTERIM REPORTS

After each monitoring event, a figure will be produced showing the sampled locations and the thickness of deposited material. Any analytical data collected will be compiled into tables presenting the preliminary data. The figure and preliminary data tables will be provided to EPA.

4.2 FINAL REPORT

After all sampling is complete, a summary report will be prepared that describes the results of all sampling conducted. At a minimum this report will present figures showing the depth of deposited material, present the validated chemical data in tables, and provide an interpretation of the data that was collected.

5.0 WASTE MANAGEMENT

All waste derived during this investigation will be placed in proper containers, labeled, characterized, and disposed of by Boeing in accordance with appropriate regulations.

6.0 HEALTH AND SAFETY

Worker health-and-safety requirements will be provided in a Site-Specific Health & Safety Plan prepared in accordance with applicable state regulations for hazardous-waste-site workers, Chapter 296-843 WAC.

7.0 REFERENCES

AMEC et al. (AMEC Environment & Infrastructure, Inc., Dalton, Olmsted & Fuglevand, Inc., and Floyd|Snider, Inc.). 2013. Construction and Post-Construction Sediment Monitoring Quality Assurance Project Plan, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. (AMEC Environment & Infrastructure, Inc., Dalton, Olmsted & Fuglevand, Inc., and Floyd|Snider, Inc.). 2014. Post-Construction Surface Sediment Monitoring Work Plan, Duwamish Sediment Other Area and Southwest Bank, Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

PSEP (Puget Sound Estuary Program). 1997. Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. Prepared for the U.S. Environmental Protection Agency and Puget Sound Water Quality Action Team.

TABLES

TABLE 1

SEDIMENT SAMPLING LOCATIONS AND ANALYSIS SCHEDULE

Additional Duwamish Sediment Other Area Backfill Sampling
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Location	State Plane Coordinates (WA SPC North NAD 83; Survey Feet)		Sample Type	Sample Depth	Initial Analysis Schedule
	Easting	Northing			
S1-1	1272914	198218	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S1-2	1272941	198248	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S2-1	1272989	198153	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S2-2	1273015	198181	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S3-1	1273063	198086	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S3-2	1273088	198113	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S4-1	1273138	198020	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S4-2	1273162	198046	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S5-1	1273212	197951	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S5-2	1273236	197978	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S6-1	1273582	197616	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S6-2	1273607	197643	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S7-1	1273953	197280	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S7-2	1273978	197308	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S8-1	1274322	196943	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S8-2	1274348	196971	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S9-1	1274706	196622	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S9-2	1274731	196649	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S10-1	1275078	196288	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S10-2	1275102	196314	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S11-1	1275448	195952	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S11-2	1275472	195978	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S12-1	1275522	195884	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S12-2	1275545	195910	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S13-1	1275597	195818	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S13-2	1275620	195844	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S14-1	1275671	195750	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S14-2	1275693	195776	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S15-1	1275744	195683	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive
S15-2	1275768	195709	Grab	0-10 cm	TOC, TS, PCBs, Grain Size, or archive

Abbreviation(s)

cm = centimeters
NAD = North American Datum
PCBs = polychlorinated biphenyls
TOC = total organic carbon
TS = total solids
WA SPC = Washington State Plan Coordinates

TABLE 2

ANALYTES, REPORTING LIMITS, SAMPLE JARS, AND HOLDING TIMES

Additional Duwamish Sediment Other Area Backfill Sampling
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Analytical Method	Reporting Limits	Minimum Sample Size	Holding Time
Conventionals				
Total Organic Carbon (Sediment)	EPA 9060/Plumb 1981	200 mg/kg	50 g	14 days @ 4°C; 6 months @ -18°C (frozen)
Total Solids	EPA 160.1/PSEP	0.10%		
Grain Size	PSEP 1986	—	100 to 200 g	6 months @ 4°C
PCBs (µg/kg)				
Total PCBs	EPA 8082	20 µg/kg per Aroclor	100 g	14 days @ 4°C; 1 year @ -18°C (frozen)
		Minimum Sample Volume	16 oz	

Abbreviation(s)

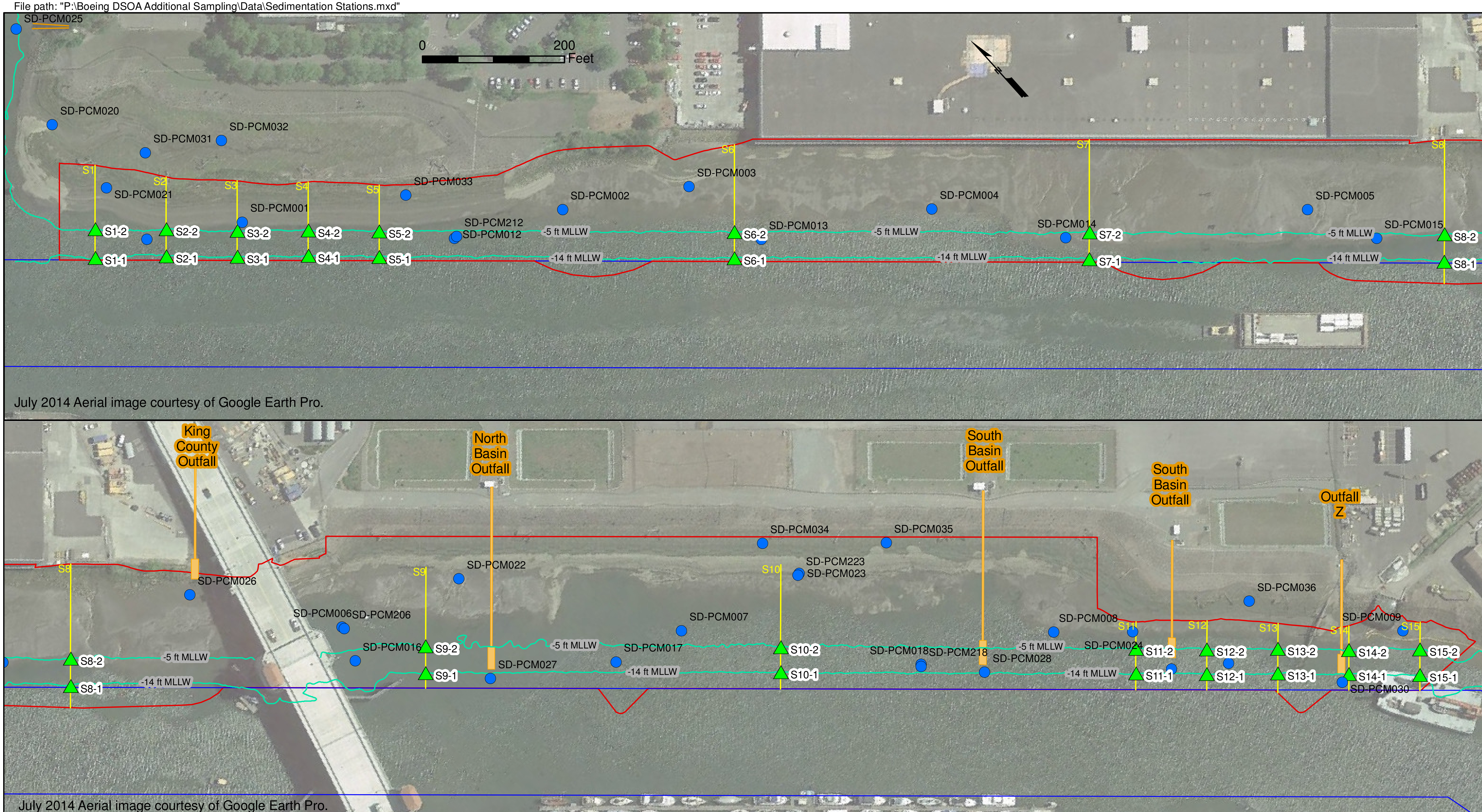
°C = degrees Celsius
µg/kg = micrograms per kilogram
EPA = U.S. Environmental Protection Agency
g = grams
mg/kg = milligrams per kilogram
oz = ounces
PCBs = polychlorinated biphenyls
PSEP = Puget Sound Estuary Program

Reference(s)

Plumb, Jr., R.H. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE-81-1. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

FIGURE

File path: "P:\Boeing DSOA Additional Sampling\Data\Sedimentation Stations.mxd"



Legend

- Post-Construction Contours
- Sample Locations
- DSOA
- Navigation Channel
- Section Lines
- Post-Construction Surface Sediment Monitoring Sample Locations

Notes:
Labels next to the proposed sample locations include the Station IDs and consist of the Section Line and the sample position (e.g., S6-2).

BOEING

PROPOSED SAMPLING LOCATIONS
Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date: 4/24/2015	Project No. LY15160330
		Figure 1

APPENDIX A

Construction and Post-Construction
Sediment Monitoring Quality Assurance Project Plan

CONSTRUCTION AND POST-CONSTRUCTION SEDIMENT MONITORING QUALITY ASSURANCE PROJECT PLAN

Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project

Boeing Plant 2

Seattle/Tukwila, Washington

AMEC Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
Floyd|Snider, Inc.

June 2013

Project 0131320080

DISTRIBUTION LIST

The following individuals or entities will receive a copy of this Quality Assurance Project Plan and any subsequent revision.

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ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
ARI	Analytical Resources, Inc.
Boeing	The Boeing Company
°C	degrees Celsius
cm	centimeters
COC	chemical of concern
CSOW	Construction Statement of Work
CVAA	cold-vapor atomic absorption
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DQI	data quality indicator
DQO	data quality objective
DSOA	Duwamish Sediment Other Area
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
HPAH	high-molecular-weight polycyclic aromatic hydrocarbons
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometry
LCS	laboratory control sample
LPAH	low-molecular-weight polycyclic aromatic hydrocarbons
m	meters
MLLW	mean lower low water
MS	matrix spike
MSD	matrix-spike duplicate
Order	Administrative Order on Consent
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan

ACRONYMS AND ABBREVIATIONS (continued)

RCRA	Resource Conservation and Recovery Act
RRM	Regional Reference Material
SIM	Selected Ion Monitoring
SMS	Sediment Management Standards
SOP	Standard Operating Procedure
SQS	Sediment Quality Standards
SRM	Standard Reference Material
SVOC	semivolatile organic compound
TEF	Toxicity Equivalency Quotient
TEQ	Toxicity Equivalency Factors
TOC	total organic carbon
USC	United States Code
VOC	volatile organic compound
WAC	Washington Administrative Code

CONSTRUCTION AND POST-CONSTRUCTION
SEDIMENT MONITORING ACTIVITIES
QUALITY ASSURANCE PROJECT PLAN
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the monitoring that will occur during the construction and post-construction phases of the Duwamish Sediment Other Area (DSOA) and Southwest Bank Corrective Measure (collectively called the Project) pursuant to the Administrative Order [RCRA Docket No 1092-01-22-3008(h)] on Consent (Order) issued to Boeing in 1994 by the U.S. Environmental Protection Agency (EPA) under authority of the Resource Conservation and Recovery Act (RCRA) Section 3008(h), as amended [42 USC 6928(h)].

This plan conforms to the substantive requirements of the EPA's *Guidance for Quality Assurance Project Plans* (QA/G-5; EPA 2002). The activities to be conducted under this QAPP are:

- Pre- and Post-Construction Perimeter Sediment Monitoring (AMEC et al. 2012a)
- Post-Construction Core Sampling (AMEC et al. 2012b)
- Post-Excavation Bank Sampling (AMEC et al. 2012c)
- Post-Construction Surface Sediment Monitoring (AMEC et al. 2012d)

Each of these activities is described in separate Work Plans.

1.1 PROJECT OVERVIEW

The purpose of the Project is to remove contaminated materials from the project site and restore/ create shoreline habitat within the DSOA and Southwest Bank at, or adjacent to, Boeing's Plant 2 Facility (Figure 1). The project area for the Project is divided into three separate subareas:

- In-Water Dredging Areas
  - Dredging with subsequent backfilling of the DSOA in-water areas
  - Dredging of sediment from 4 areas with subsequent backfilling within the Boeing owned portion of Slip 4

- North Shoreline Area
  - Excavation of the shoreline to create an intertidal embayment
  - Shoreline habitat restoration
- South Shoreline Area
  - Demolition of the over-water portion of the former 2-40s building complex
  - Excavation of the 2-40s complex Under-building area
  - Removal of bank fill material from the Southwest Bank and shoreline area
  - Shoreline habitat restoration

Further description and figures depicting these areas are provided in the *Final Design Report* and *Final Construction Statement of Work* (CSOW; AMEC et al. 2012e and 2012f, respectively).

The construction is expected to start in fall 2012. The construction start date is dependent on securing the necessary permits and approvals from the various regulatory agencies. The construction duration is anticipated to be 3 years, depending on the permissible in-water construction work window.

1.2 MONITORING TASKS

The scheduling of monitoring efforts depends on the scheduling and completion of specific construction tasks. Between the four activities, monitoring will be conducted prior to, during, and after construction. A timeline for the various monitoring tasks is presented in Figure 2. A brief description of each of the monitoring tasks is provided below. Separate Work Plans (provided under separate cover) for each of the monitoring activities provide details of the sampling design, the sampling methods, and reporting.

1.2.1 Pre- and Post-Construction Perimeter Sediment Monitoring

The pre- and post-construction perimeter sediment monitoring program will be conducted to determine if there are material increases in concentration of chemicals of concern (COCs) in the post-remediation perimeter surface sampling stations outside the DSOA (Figure 3) relative to the pre-remediation concentrations.

The sampling design is a judgmental sampling design. Sample locations were determined using best professional judgment. Sample locations were selected to provide spatial coverage adjacent to the DSOA and the Slip 4 In-Water Dredging Areas (Figure 3). Sample locations were placed downstream of the construction zone, adjacent to the construction zones, upstream of the construction area, and within Slip 4 from the approximate middle of the cap area at the head of the slip to the mouth of the slip. If other cleanup projects are scheduled to occur upstream or downstream of the project site, additional sampling may be conducted at some locations prior to the start of the other projects (e.g., Jorgensen Forge, T-117).

The COCs to be monitored are the Sediment Management Standards (SMS; 173-204 WAC) metals and polychlorinated biphenyls (PCBs; Table 1). The COCs for the project were identified by EPA in the *Final Decision and Response to Comments for Boeing Plant 2 Sediments* (EPA 2011).

1.2.2 Post-Construction Core Sampling

The objective of the post-construction/pre-backfill core sampling program is to characterize sediments that are left in place after completion of the remedial dredging. The results of this characterization will not trigger any additional action including dredging.

The sampling design is a judgmental sampling design. Sample locations were determined using best professional judgment. Sample locations were selected to provide good spatial coverage horizontally within the DSOA and Slip 4 In-Water Dredging Areas and vertically across the range of dredge cut depths (Figure 4 and Figure 5).

The post-construction core sampling will be conducted after the dredging work in an area is complete. Sampling should be conducted after the dredge unit is surveyed and accepted by the Boeing construction manager and before the placement of the initial lift of backfill (placement of approximately 6 inches of gravel/sand). However, scheduling of each individual sampling event may be complicated by the uncertainty associated with the completion of dredging within a dredge unit, surveying of each unit to document meeting the proposed dredge depths, and acceptance of the dredge unit. If mobilization for the coring cannot be conducted in a timely manner, then the placement of an initial lift of granular fill may be conducted as required by the Best Management Practices listed in the *Final Design Report* (AMEC et al. 2012e). Sampling through the initial lift of granular fill (approximately 6 inches) will then be conducted. The interface between the clean granular fill and the finer-grained residual material left following the dredging will be determined visually. Sample intervals will include this residual material but the granular fill material will be excluded to minimize diluting the residual concentrations.

The COCs to be monitored are the SMS metals and PCBs (Table 1). The COCs for the project were identified by EPA in the *Final Decision and Response to Comments for Boeing Plant 2 Sediments* (EPA 2011).

1.2.3 Post-Excavation Bank Sampling

The objective of the post-excavation/pre-backfill bank sampling program is to characterize soils that are left in place after completion of the shoreline excavation in the South Shoreline Area. This sampling program will also characterize soils left in place after excavation of RCRA units within and adjacent to the footprint of the former 2-40s building complex. The results of this characterization will not trigger any additional actions.

The sampling design is a judgmental sampling design. Sample locations were determined using best professional judgment. Sample locations were selected to provide good spatial coverage across the shoreline within the footprint of the former 2-40s building complex (Figure 6). Additional bank samples will be collected along the Southwest Bank area. Additional RCRA Unit Record Samples will be collected within the RCRA units excavated during project construction.

The post-excavation bank samples will be collected prior to backfill placement. Sampling will be conducted when the area surrounding a sample location is excavated to final grade and prior to backfilling. Sampling will be conducted by hand: either by sampling the exposed *in situ* soils exposed at the bottom of the excavation, or by sampling soils from the excavator bucket (if access or safety issues are of concern).

All bank samples will be analyzed for the SMS list of metals and PCBs (Table 1). In addition, selected bank samples will be analyzed for the SMS list of phthalates. Selected RCRA Unit Record Samples will be analyzed for one or more of the following analytes: PCBs, SMS metals, SMS list of phthalates (Table 1), or selected volatile organic compounds (VOCs) (Table 2).

1.2.4 Post-Construction Surface Sediment Monitoring

The post-construction surface sediment monitoring program will be conducted to determine if recontamination of the clean post-construction sediment surface is occurring and if any recontamination is from on- or off-site sources. Potential on-site sources are groundwater and stormwater which are being monitored through the ongoing uplands RCRA process. No specific monitoring of groundwater is being conducted as part of this program; however, sediments adjacent to Plant 2 vicinity stormwater outfalls will be sampled.

Recontamination from off-site sources will be monitored as part of this program. Off-site sources include, but are not limited to, releases or resuspension of sediments and subsequent transport and sediment deposition from either upstream or downstream of the site.

The sampling design is a judgmental sampling design. Sample locations were determined using best professional judgment. Proposed sample locations were selected to provide good spatial coverage and to collect data near stormwater outfalls (Figure 7 and Figure 8). The distribution of the samples was stratified based on the estimated elevation of the sediment surface (feet mean lower low water [MLLW]) of the final finish grade. Additional samples were placed within the North and South Shoreline habitat planting areas as requested by the Natural Resource Trustees.

The COCs to be monitored are the SMS list of chemicals (Table 1) and dioxins/furans (Table 2). Post-construction monitoring will be conducted immediately after all dredging, shoreline construction, and final backfilling to grade has been completed (Year 0). Additional monitoring will be conducted at years 1, 3, 5, 7, and 10 post-construction.

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2.0 PROJECT MANAGEMENT

This section provides the project management team structure, lines of authority, and reporting responsibilities.

2.1 PROJECT ORGANIZATION

An organizational chart showing lines of authority and reporting responsibilities is presented on Figure 9.

2.1.1 The Boeing Company

Mike Gleason will be the Boeing Project Manager. His responsibilities include project direction and project oversight, site security, profiling and disposal of wastes generated, personnel access badges, space allocation, site usage, and other miscellaneous support items associated with planning and performance of the work.

2.1.2 Boeing Consultant Team

AMEC Environment & Infrastructure, Inc. (AMEC) is the prime consultant working under contract to Boeing for the Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project.

The consultant team for this project will perform the following duties:

- Communicate with and oversee the analytical laboratory to ensure that project goals are met.
- Coordinate sample analysis with the analytical laboratory.
- Provide all equipment for sediment sampling and analysis as described in the attached Work Plans.
- Establish and follow chain-of-custody procedures.
- Oversee compliance with the Site-Specific Health & Safety Plan.
- Perform field and data quality reviews.
- Prepare a data report as described in Section 4.2.

2.1.2.1 Consultant Team Project Manager

AMEC's project manager is Cliff Whitmus. He will be responsible for the overall conduct of the work described in this QAPP.

2.1.2.2 Quality Assurance Manager

Rob Gilmour of AMEC will be the Quality Assurance (QA) Manager for the project. He will be responsible for performing field and quality reviews and ensuring that the sampling and analysis is conducted per the requirements specified in this QAPP.

2.1.2.3 Field Manager

Gary Maxwell of AMEC will be the Field Manager for the project. He will be responsible for:

- Ensuring that all samples are collected in accordance with this QAPP.
- Establishing and following chain-of-custody procedures.
- Overseeing compliance with the Site-Specific Health & Safety Plan.
- Ensuring that all sediment sampling and analysis equipment as described in the Work Plans is available and in working order.

2.1.2.4 Laboratory Coordinator

Crystal Neirby of AMEC will be the Laboratory Coordinator for the work conducted under this QAPP. She will:

- Communicate with and oversee the analytical laboratory, to ensure that project goals are met.
- Coordinate sample analysis with the analytical laboratory.

2.1.2.5 Data Management

Cari Sayler of Sayler Data Solutions, Inc. will be responsible for the analytical data management for the project. She will:

- Import the electronic data deliverable (EDD) provided by the analytical laboratory into a data management system.
- Produce analytical data tables for the Data Report that will be produced as part of this work.
- Produce the Environmental Information Management (EIM)-compatible EDD.

2.1.2.6 Data Validation

Cari Sayler will also perform the validation of all analytical data as described in Section 5.0 of this QAPP.

2.1.2.7 Analytical Laboratory Project Manager

Analytical testing will be conducted by Analytical Resources, Inc. (ARI). ARI is a full-service Washington-accredited chemical analytical laboratory located in Tukwila, Washington. Kelly Bottem will be the ARI Project Manager. ARI will perform the following duties:

- Perform all laboratory chemical analyses.
- Meet QA requirements outlined in Section 2.2 of this QAPP.
- Provide storage for all frozen archived sediment samples in a temperature-monitored freezer at -18 degrees Celsius (°C).

2.2 QUALITY OBJECTIVES AND CRITERIA

2.2.1 Quality Objectives and Criteria for Analytical Data

Analytical data should meet the project data quality objectives (DQOs). The DQOs indicate that the data must be accurate enough to compare with the SMS Sediment Quality Standards (SQS; 173-204-320 WAC) for marine sediments (Table 3). Because the SQS for the nonionizable organic compounds are based on carbon-normalized concentrations, measurements of the total organic carbon (TOC) of the samples must also be made. Comparison of carbon-normalized values against the SQS listed in Table 3 may be inappropriate if TOC values are below 0.5 percent or above 4 percent. At TOC concentrations below 0.5 percent and above 4 percent, the project DQOs for nonionizable organic compounds must be accurate at the SQS dry-weight equivalent standards in Table 3. The specific target detection limits are presented in Table 1. There are no SQS criteria for sediment VOCs or for dioxins/furans; therefore, the DQOs for sediment VOCs and the dioxin/furan congeners are based on the analytical laboratory's reporting limit for EPA Method 8260C—VOC analysis of soil and sediment and EPA Method 1613B—Dioxin analysis of soil and sediment , respectively (Table 2).

To meet the goal of returning data accurate to the SQS or other criteria, data quality indicators (DQIs) for specific measured parameters, including the familiar PARCC (precision, accuracy, representativeness, comparability, and completeness) parameters and sensitivity are required. The basis for assessing each of these elements of data quality is discussed in the following sections. Precision and accuracy quality control (QC) limits for Methods 6010/6020, Method 7000, Method 8270D, Method 8082, Method 8260C, and Method 1613B are contained in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9, respectively.

2.2.2 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. If the recoveries of analytes in the laboratory control sample (LCS) are within established control limits, then precision is within limits. Total precision is the measurement of the variability associated with the entire sampling and analysis process and is determined by analysis of duplicate or replicate field samples. Total precision measures the variability introduced by both the laboratory and field operations. Field-duplicate samples (10 percent frequency) and matrix-duplicate spiked samples (1 per 20 samples) will be analyzed to assess field and analytical precision using the relative percent difference between the duplicate sample results. For replicate analyses, the relative standard deviation is determined.

2.2.3 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systematic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For compounds such as PCBs, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed.

Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements. The sample batch for both the LCS and method blank includes up to 20 samples extracted together. The formula for calculation of accuracy returns a percent recovery from pure and sample matrices. Limits of accuracy for Methods 6010/6020, Method 7000, Method 8270D, Method 8082 (PCBs), Method 8260C (VOCs), and Method 1613B (Dioxins) are contained in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9, respectively.

2.2.4 Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of investigative objectives. Representativeness will be achieved by using the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design, with consideration of elements such as proper sample locations, sampling procedures, and sampling intervals. Decisions regarding sample locations and sample intervals are documented in the individual Work Plans for each sediment monitoring activity.

2.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another data set. An objective for this QA/QC program is to produce data comparable to previously collected data. The range of field conditions encountered is considered in determining comparability. Comparability will be achieved by using standard methods for sampling and analysis, reporting data in standard units, using Regional Reference Material (RRM) or Standard Reference Material (SRM), and using standard reporting formats. Field documentation using standardized data-collection forms will support the assessment of comparability.

2.2.6 Completeness

Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an “R” flag (see Table 10 for an explanation of flagging criteria). The requirement for completeness is 90 percent for the sediment samples scheduled for the initial round of analyses.

2.3 DOCUMENTATION AND RECORDS

Data and log forms produced in the field will be reviewed daily by the person recording the data so that any errors or omissions can be corrected. All completed data sheets are removed from the field clipboard and photocopied; the original data sheets are filed in a fireproof file cabinet and the photocopies stored in the project file. All data transcribed from field forms into electronic forms and tables will be 100 percent verified for accuracy and freedom from transcription errors.

Laboratory documentation will consist of a case narrative, providing descriptions of any problems and corrective actions, copies of the chain-of-custody forms, tabulated analytical results, data qualifiers, and blank and matrix-spike results with calculated percent recoveries and differences. A more detailed documentation package (raw data, analyst’s reports, extraction logs, chromatograms, etc.) will be provided by the laboratory in case the summary data review discussed in Section 5.1 encounters deficiencies requiring more thorough laboratory documentation.

Field documentation will consist of forms presented in the Work Plans. All project documentation records will be kept on file at the offices of AMEC in Lynnwood, Washington. All data generated as part of this QAPP will be retained at the offices of AMEC and Boeing as specified in the Administrative Order on Consent.

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3.0 DATA GENERATION AND ACQUISITION

This section describes the sampling methods, analytical methods, quality control, instrument and equipment testing, and data management for data generation and acquisition.

3.1 SAMPLING METHODS

3.1.1 Equipment Decontamination

Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment sample material must meet high standards of cleanliness. Sample containers will be provided by ARI, and are pre-cleaned, certified, and individually labeled with a lot number traceable to a Certificate of Analysis.

All core tubes and sediment-handling equipment will be cleaned and decontaminated prior to arrival at the site. Aluminum core tubes will be discarded after use. The grab sampler will be pre-cleaned prior to arrival at the site and cleaned between each location using the procedure described below. All equipment and instruments used to remove sediment from the sampler or to homogenize samples will be stainless steel and will be decontaminated before and in between each use. The AMEC standard decontamination procedure for the grab sampler, core tubes, and other sample handling equipment is modeled after Puget Sound Estuary Program (PSEP) protocols (PSEP 1997); however, the decontamination procedure will not use any acid or solvent rinses (the final rinse will use distilled water). The decontamination procedure is as follows:

1. Prewash rinse with tap water.
2. First wash with solution of tap water and Alconox soap (brush).
3. Second rinse with tap water.
4. Second wash with solution of tap water and Alconox soap (brush).
5. Final rinse with tap water.
6. Final rinse with distilled water.
7. Wrap all decontaminated items with aluminum foil.
8. Storage in clean, closed container prior to use.

3.1.2 Core Sediment Samples

Core samples will be collected as part of the Post-Construction Core Sampling program. Core samples may be collected using an impact or vibratory corer. If penetration or recovery is insufficient to meet the study needs, additional methods may be used.

The impact corer uses the impact from the linear pneumatic hammer, delivering approximately 300 blows per minute to drive a 4-inch-square aluminum core into the sediment. This allows for a continuous core sample to be collected over the depth that the tube is driven. The bottom of each core tube will be fitted with a hinged core catcher to prevent loss of the sediment during extraction.

A vibratory corer uses the weight and the vibration generated by the vibratory head to drive a 4-inch-square aluminum core into the sediment. A continuous core sample is collected over the depth that the tube is driven. The bottom of each core tube will be fitted with a core catcher to prevent loss of the sediment during extraction.

The intent of the core sampling is to collect sediment samples below the excavated sediment surface (i.e., leave surface). Surface samples (representing either the 0- to 10-centimeter (cm) layer in Slip 4 or the 0- to 1-foot layer in the DSOA) will be collected (including any residual material resting on the leave surface). If a layer of granular backfill is placed post-dredging but before sampling is conducted within a dredge unit, then the surface sample interval will include the residual layer and the sediment left in place. The granular backfill will not be included in the representative surface sample. Cores will be advanced a minimum of 4 feet below mudline. Samples will be collected that represent the *in situ* intervals specified in the work plan. If penetration of, or recovery in, the core is insufficient to meet the study needs, one additional core sample will be collected at a specific location.

Detailed sediment collection and handling procedures are presented in the Work Plans. The handling and processing of sediment cores will occur within a secured exclusion zone using Level D protection following the requirements specified in the Site-Specific Health & Safety Plan. One core tube will be handled and processed at a time. Cores collected will be held for a maximum of 24 hours before processing. Unprocessed cores held more than 8 hours will be chilled with ice.

3.1.3 Surface Grab Samples

Surficial sediment samples collected with a grab sampler will be collected for the Pre- and Post-Construction Perimeter Monitoring and the Post-Construction Surface Sediment Monitoring programs. Surficial sediment samples will be collected using a 0.1-m^2 stainless-steel van Veen sampler or 0.2-m^2 stainless-steel powered grab sampler. Surface sediments to a depth of 10 cm will be collected to meet sample volume requirements. Sediments touching the sides of the grab sampler will not be collected or included in the homogenized samples. The sampler will be decontaminated prior to arrival at the site and between sample locations in accordance with the procedures in Section 3.1.1.

The following acceptability criteria for the grab samples should be satisfied:

- The sampler is not overfilled with the sample such that the sediment surface is pressed against the top of the sampler.

- Overlying water is present (indicates minimal leakage).
- The overlying water is not excessively turbid (clear water indicates minimal sample disturbance).
- The sediment surface is relatively flat (indicates minimal disturbance or winnowing).
- The sediment surface does not show evidence of previous coring attempts.
- The penetration depth is at least 15 cm for a 10-cm-deep surficial sample.

If a sample does not meet any one of these criteria, it will be rejected and another grab collected.

Overlying water is slowly siphoned off near one side of the sampler with a minimum of sample disturbance. Sample material that is, or has been, in direct contact with the grab sampler will not be included in the sample volume.

3.1.4 Hand Collection of Surface Sediments

Hand collected samples will be collected for the Post-Excavation Bank Sampling program and for the upper intertidal samples collected for the Post-Construction Surface Sediment Monitoring program. Hand collection methods for sediments will include the use of trowels, spoons, or shovels to collect sediments exposed during excavations. Loose disturbed soils or sediments will not be collected or included in the samples. The unconsolidated overburden will be removed and samples representing the undisturbed soils or sediments will be collected to a depth of 1 foot below the interface. Sampling may be conducted from the bucket of the excavator if access and safety concerns limit access to the exposed sediment surface. All equipment and instruments used to collect the samples will be disposable stainless steel and will be decontaminated prior to arrival at the site in accordance with the procedures in Section 3.1.1.

3.2 SAMPLE HANDLING AND CUSTODY

3.2.1 Sample Handling Procedures

Unopened and unprocessed core tubes will be kept in sight of the sampling crew or in a secure area at all times. Grab samples will be processed as soon as they are collected. Sediment samples also will be kept in sight of the sampling crew or in a secure, locked vehicle at all times. Samples will be transported to the AMEC office at the end of the day for storage (samples will be placed in coolers with “blue ice” or frozen) until transferred to the testing laboratories. Transfer of samples from AMEC custody to the laboratory will be documented using chain-of-custody procedures. Coolers used to transport samples will be sealed with a Custody Seal before shipping if delivered by courier.

Surplus sample material will be archived and stored at the analytical laboratory in a secure area. Storage requirements for all archived samples will include freezing and storage of the samples in a temperature-monitored freezer at -18°C.

3.2.2 Sediment Analysis Schedule

The COCs for the different sediment monitoring activities include the SMS list of COCs, TOC, and at selected locations, VOCs (Table 11). The detailed list of the sediment samples with the proposed analyses are presented in the individual Work Plans. Surplus sample volume will be frozen (-18°C) and archived at the analytical laboratory.

3.2.3 Field Quality Assurance

Field QC will include the collection and analysis of duplicate samples at approximately a 10 percent frequency. Field QC samples for the sediment investigation will be determined during field sampling.

Decontamination (rinsate) blanks will not be collected during:

- coring investigations due to the use of all pre-cleaned, disposable sampling equipment as described in the *Post-Construction Core Sampling Work Plan* (AMEC et al. 2012b);
- sampling using a grab sampler as described in the *Pre- and Post-Construction Perimeter Sediment Monitoring Work Plan* (AMEC et al. 2012a) and the *Post-Construction Surface Sediment Monitoring Work Plan* (AMEC et al. 2012d) since sediments touching the side of the sampler will not be collected and the use of all pre-cleaned, disposable sampling equipment; and
- collection of samples by hand due to the use of all pre-cleaned, disposable sampling equipment as described in the *Post-Excavation Bank Sampling Work Plan* (AMEC et al. 2012c).

Samples will be handled using the standard chain-of-custody procedures. Data and log forms produced in the field will be reviewed daily by the person recording the data, so that any errors or omissions can be corrected. All completed data sheets are removed daily from the field clipboard and photocopied; the original data sheets are filed in a fireproof file cabinet and the photocopies stored in the project file. All data transcribed from field forms into electronic forms and tables will be 100 percent verified for accuracy and freedom from transcription errors.

3.3 ANALYTICAL METHODS

The analysis methods chosen for the sediment samples must be able to return accurate results at the concentrations listed in Table 1 and Table 2. The test method selected to achieve these results is described in Table 1 and Table 2 along with the reporting limits for the analysis provided by ARI.

Sediment samples will be homogenized at the analytical laboratory (see the Work Plans) for analysis of any of the SMS COCs, dioxins, or TOC. Samples for VOC analysis will not be homogenized.

As described in the SMS, total high-molecular-weight polycyclic aromatic hydrocarbons (HPAH) concentrations will be calculated by summing the detected concentrations of flouranthene, pyrene, benz(a)anthracene, chrysene, total benzoflouranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a)anthracene, and benzo(g,h,i)perylene. If all the HPAHs are reported as undetected, the highest undetected value is reported as the total HPAH value.

Total low-molecular-weight polycyclic aromatic hydrocarbons (LPAH) concentrations will be calculated by summing the detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorine, phenanthene, and anthracene. The compound 2-methylnapthalene is reported as a LPAH but is not included in the calculated total. If all the LPAHs are reported as undetected, the highest undetected value is reported as the total LPAH value.

Total PCB concentrations will be calculated by summing the detected concentrations for seven Aroclors (Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260). Undetected Aroclors will not be included in the calculation of total PCB values. If all seven Aroclors are reported as undetected, the highest undetected value is reported as the total PCB value. In the event that Aroclor concentrations are extremely elevated and therefore require dilution, a different extraction procedure may be used.

ARI will use a sulfuric acid cleanup (EPA Method 3665B) to remove excess oil residue and interferences. Furthermore, ARI will perform a sulfur cleanup (EPA Method 3660B) for these samples. This additional processing will help limit potential environmental interferences.

Elevated reporting limits for certain Aroclors can result from several causes, most commonly a result of dilution or sample interferences. In very-high-concentration samples, dilution may be necessary to accurately quantitate the Aroclor(s) present in the highest concentration(s). This can result in elevated quantitation limits for other Aroclor(s) as reporting limits must be multiplied by the dilution factor. Sample interferences can raise the baseline of the chromatogram above reporting-limit resolution. If such interferences result in elevated reporting limits above DQOs, ARI will perform additional cleanup of the extract to try to remove these interferences (see Section 4.1.2).

Dioxins and furans will be analyzed using an EPA Method 1613B. A Toxicity Equivalency Quotient (TEQ) will be calculated using the World Health Organization 2005 (Van den Berg et al. 2006) Toxicity Equivalency Factors (TEF) for the 2,3,7,8 substituted congeners.

All sediment analyses will be conducted using the laboratory’s standard turnaround time of approximately 3 weeks.

3.4 QUALITY CONTROL

For the field, QC checks include the collection and analysis of duplicate samples (10 percent frequency; except for the Pre- and Post-Construction Perimeter Sediment Monitoring [see rationale in Work Plan]) and standardized sampling documentation forms (see the Work Plans). Trip blanks will be included in each cooler used to transport and store sample containers used for VOC analysis.

Laboratory QC checks include using standard EPA analytical methods, performing method-specified QC samples (such as including analysis method blanks, spikes, and surrogates), and meeting method-specified calibration and system performance criteria. These QC checks are detailed in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9. Analyses will be carried out under the laboratory's Standard Operating Procedures (SOPs).

The Dredged Material Management Program's (DMMP's) Regional Reference Material (RRM) for dioxins/furans and PCBs and a Standard Reference Material (SRM) for TOC will be run with every third batch of samples, beginning with the first batch. One matrix spike/matrix-spike duplicate (MS/MSD) will be run every sample delivery group of 20 samples or less to evaluate matrix interferences and recoveries. Additional sample volume will be collected to meet the analysis needs.

3.5 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, MAINTENANCE, AND CALIBRATION

3.5.1 Field Equipment

Prior to each daily sampling event, the differential global positioning system (DGPS) will be tested for accuracy. A checkpoint accessible to the field crew will be occupied. At the DGPS checkpoint, the DGPS unit will be stationed and a position reading will be taken (Figure 10). The DGPS position will be compared to the known checkpoint coordinates. The DGPS position readings should agree to within 1 to 2 meters (m) of the known checkpoint coordinates. If the position readings do not agree within 1 to 2 m, the DGPS unit will be carefully checked and electronics reset. After checking and resetting the DGPS, if the positions still do not agree, other actions may be taken including replacing the unit.

3.5.2 Analytical Laboratory

Analytical instruments will be calibrated according to the analytical methods specified in the laboratory SOPs. All analytes reported will be present in the initial and continuing calibrations, and these calibrations will meet the acceptance criteria specified in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9. Records of standard preparation and instrument calibration will be maintained, and calibration standards shall be traceable to standard materials.

Instrument calibration will be checked at the frequency specified in the method using materials prepared independently of the LCSs. Multipoint calibrations will contain the minimum number of calibration points specified in the method, with all points used for the calibration being contiguous. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed will be included in the initial calibration. The continuing calibration verification cannot be used as the LCS.

3.6 INSPECTION AND ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The Field Manager will be responsible for ensuring that all supplies necessary to conduct the sampling, including collecting, processing, and transporting samples, are available and in good working order at the beginning of the fieldwork. The Field Manager will monitor supplies and equipment throughout sampling and replenish or replace as necessary.

3.7 NONDIRECT MEASUREMENTS

No nondirect measurements will be made on this project.

3.8 DATA MANAGEMENT

The analytical and field data will be compiled into an Environmental Information Management (EIM)-compatible electronic data deliverable for submission to EPA. The analytical data will also be maintained in ARI's electronic Laboratory Information Management System.

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4.0 ASSESSMENT AND OVERSIGHT

This section describes responsibilities for assessment and oversight of equipment, corrective actions, and data reports.

4.1 ASSESSMENTS AND RESPONSE ACTIONS

4.1.1 Field

The Field Manager will be responsible for correcting equipment malfunctions during the field sampling. In addition to equipment failures, conditions that require a modification of the intent of the sampling program will be coordinated with Boeing and EPA by the Field Manager or the Consultant Team Project Manager. All response actions will be documented on field forms or in a logbook.

4.1.2 Analytical Laboratory

ARI participates in the Washington State Department of Ecology (Ecology's) Environmental Laboratory Accreditation Program and has participated in the EPA Contract Laboratory Program. The laboratory is periodically audited by a variety of outside agencies, including EPA, Ecology, Corps of Engineers, and the Washington State Department of Health. Results of recent audits are available from ARI.

Corrective actions will occur whenever the QC limits for each method specified in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9 are exceeded. Details of the corrective actions are in the laboratory SOPs for each analytical method.

Whenever a corrective action occurs, the Analytical Laboratory Project Manager is notified. If the corrective action is judged to be routine, such as a slight exceedance of a percent-recovery limit, the corrective action will be implemented without notification of the Consultant Team Project Manager. If the corrective action requires reanalysis or re-extraction, the Consultant Team Project Manager and Laboratory Coordinator will be notified.

For PCB analyses, if environmental interferences result in ARI not attaining the reporting limit, the Consultant Team Project Manager and Laboratory Coordinator will be notified and gel-permeation cleanup (EPA Method 3640A) will be performed before reanalysis. Because sediment samples will be frozen following removal of material for the initial analyses, which allows for a 1-year hold time, the laboratory will be able to re-extract and reanalyze samples well within the holding-time interval.

Sediment samples for VOC analysis will be refrigerated at 4ºC. Refrigerated samples may be held for up to 14 days to allow time for reanalysis if needed.

4.2 REPORTS TO MANAGEMENT

A data report summarizing the results of each round of monitoring will be prepared by the consultant team and the Boeing Project Manager for submittal to EPA. This report will include a narrative of field activities, chain-of-custody records, data tables and maps for sample locations, data tables and maps summarizing the results of the analytical analyses, and electronic data tables.

5.0 DATA VALIDATION AND USABILITY

This section describes procedures for data validation, verification, and usability.

5.1 DATA REVIEW, VERIFICATION, AND VALIDATION

All data packages (with the exception of dioxin /furan analysis) will be verified at a Stage 2B validation. This Stage 2B review includes the following verification and validation checks:

- Verify that sample numbers and analyses match those requested on the chain-of-custody form.
- Verify that the laboratory utilized the specified extract, analysis, and cleanup methods.
- Verify that the required reporting limits have been achieved.
- Verify that field duplicates, matrix spikes, and laboratory control samples were run at the proper frequency and have met QC criteria.
- Verify that the surrogate compound analyses have been performed and have met QC criteria.
- Review sample holding time.
- Verify that initial and continuing calibrations were run at the proper frequency and have met acceptance criteria.
- Verify that the laboratory blanks are free of contaminants.

Dioxin/furan analysis conducted using EPA Method 1613B will be subjected to a Stage 4 validation. This Stage 4 review builds on the Stage 2B validation and includes additional recalculation of instrument and sample results, and also includes an evaluation of the instrument outputs.

5.2 VERIFICATION AND VALIDATION METHODS

Data that appear to have significant deficiencies will be validated using the more comprehensive Stage 3 or a Stage 4 verification and review in accordance with the EPA's guidance for labeling externally validated analytical data (EPA 2009). Following this review, data qualifiers assigned by the laboratory may be amended with the data validation qualifiers described in Table 10.

5.3 RECONCILIATION WITH USER REQUIREMENTS

Following receipt of all of the analytical data reports, the Consultant Team Project Manager and the Boeing Project Manager will review the sample results to determine if they fall within the acceptance limits and goals in this Quality Assurance Project Plan. If the DQIs do not meet project requirements, the data may be discarded and reanalysis performed. This decision will be made jointly between the consultant team and Boeing. If the failure is traced to the analytical laboratory, sample handling, extraction, or instrument calibration and maintenance, techniques will be reassessed before reanalysis.

6.0 SCHEDULE

The data report for the work will be submitted to EPA within 30 days of completion of the data validation.

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7.0 HEALTH AND SAFETY

Worker health-and-safety requirements will be provided in a Site-Specific Health & Safety Plan prepared in accordance with applicable state regulations for hazardous-waste-site workers, Chapter 296-843 WAC.

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8.0 REFERENCES

AMEC et al. (AMEC Environment & Infrastructure, Inc., Dalton, Olmsted & Fuglevand, Inc., and Floyd|Snider, Inc.). 2012a. Pre- and Post-Construction Perimeter Sediment Monitoring Work Plan, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. 2012b. Post-Construction Core Sampling Work Plan, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. 2012c. Post-Excavation Bank Sampling Work Plan, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. 2012d. Post-Construction Surface Sediment Monitoring Work Plan, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. 2012e. Final Design Report, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

AMEC et al. 2012f. Final Construction Statement of Work, Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project, Boeing Plant 2, Seattle/Tukwila, Washington. Prepared for The Boeing Company, Seattle, Washington.

EPA (U.S. Environmental Protection Agency). 2002. Guidance for Quality Assurance Project Plans, EPA QA/G-5. EPA, Office of Environmental Information, EPA/240/R-02/009, Washington, D.C.

EPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. EPA, Office of Solid Waste and Emergency Response, OSWER No. 9200.1-85, EPA 540-R-08-005, Washington, D.C.

EPA. 2011. Final Decision and Response to Comments for Boeing Plant 2 Sediments, Duwamish Sediment Other Area and Southwest Bank, Boeing Plant 2, Seattle/Tukwila, Washington, Resource Conservation and Recovery Act (RCRA) Docket No 1092-01-22-3008(h), EPA ID No. WAD 00925 6819. EPA Region 10, Seattle, Washington.

PSEP (Puget Sound Estuary Program). 1997. Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. Prepared for the U.S. Environmental Protection Agency and Puget Sound Water Quality Action Team.

Van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Toumisto, M. Tysklind, N. Walker, and R.E. Peterson. 2006. The 2005 World Health

Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. Toxicological Sciences, v. 93(2), p. 223-241.

TABLES

TABLE 1

SEDIMENT MANAGEMENT STANDARDS CHEMICALS OF CONCERN, ANALYTICAL METHODS, AND REPORTING LIMITS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Sample Preparation/ Extraction	Analytical Method	Reporting Limit [1]
Metals (mg/kg)			
Arsenic	EPA 3050	EPA 6010 (ICP-OES)	5.0
Cadmium	EPA 3050	EPA 6010 (ICP-OES)	0.2
Chromium	EPA 3050	EPA 6010 (ICP-OES)	0.5
Copper	EPA 3050	EPA 6010 (ICP-OES)	0.2
Lead	EPA 3050	EPA 6010 (ICP-OES)	2.0
Mercury	EPA 7471A	EPA 7471A (CVAA)	0.025
Silver	EPA 3050	EPA 6010 (ICP-OES)	0.3
Zinc	EPA 3050	EPA 6010 (ICP-OES)	1.0
Nonionizable Organic Compounds			
Aromatic Hydrocarbons (µg/kg)			
Total LPAH	—	—	—
Naphthalene	EPA 3546	EPA 8270D - PSEP	20
Acenaphthylene	EPA 3546	EPA 8270D - PSEP	20
Acenaphthene	EPA 3546	EPA 8270D - PSEP	20
Fluorene	EPA 3546	EPA 8270D - PSEP	20
Phenanthrene	EPA 3546	EPA 8270D - PSEP	20
Anthracene	EPA 3546	EPA 8270D - PSEP	20
2-Methylnaphthalene	EPA 3546	EPA 8270D - PSEP	20
Total HPAH	—	—	—
Fluoranthene	EPA 3546	EPA 8270D - PSEP	20
Pyrene	EPA 3546	EPA 8270D - PSEP	20
Benz[a]anthracene	EPA 3546	EPA 8270D - PSEP	20
Chrysene	EPA 3546	EPA 8270D - PSEP	20
Benzofluoranthenes	EPA 3546	EPA 8270D - PSEP	20
Benzo[a]pyrene	EPA 3546	EPA 8270D - PSEP	20
Indeno[1,2,3-c,d]pyrene	EPA 3546	EPA 8270D - PSEP	20
Dibenzo[a,h]anthracene	EPA 3546	EPA 8270D - PSEP	20
Benzo[g,h,i]perylene	EPA 3546	EPA 8270D - PSEP	20
Chlorinated Benzenes (µg/kg)			
1,2-Dichlorobenzene	EPA 3546	EPA 8270D SIM	5
1,4-Dichlorobenzene	EPA 3546	EPA 8270D SIM	5
1,2,4-Trichlorobenzene	EPA 3546	EPA 8270D SIM	5
Hexachlorobenzene	EPA 3546	EPA 8270D SIM	5
Phthalate Esters (µg/kg)			
Dimethyl phthalate	EPA 3546	EPA 8270D SIM	5
Diethyl phthalate	EPA 3546	EPA 8270D SIM	5
Di-n-butyl phthalate	EPA 3546	EPA 8270D - PSEP	20
Butyl benzyl phthalate	EPA 3546	EPA 8270D SIM	5
Bis[2-ethylhexyl]phthalate	EPA 3546	EPA 8270D - PSEP	25
Di-n-octyl phthalate	EPA 3546	EPA 8270D - PSEP	20

TABLE 1

SEDIMENT MANAGEMENT STANDARDS CHEMICALS OF CONCERN, ANALYTICAL METHODS, AND REPORTING LIMITS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Sample Preparation/ Extraction	Analytical Method	Reporting Limit [1]
Miscellaneous (μg/kg)			
Dibenzofuran	EPA 3546	EPA 8270D - PSEP	20
Hexachlorobutadiene	EPA 3546	EPA 8270D SIM	5
N-nitrosodiphenylamine	EPA 3546	EPA 8270D - PSEP	20
Pesticides and PCBs (μg/kg)			
Total PCBs [2]	PSDDA Sonication [3] (low levels)	EPA 8082	20 μg/kg per Aroclor
Ionizable Organic Compounds (μg/kg)			
Phenol	EPA 3546	EPA 8270D - PSEP	20
2-Methylphenol	EPA 3546	EPA 8270D SIM - PSEP	5
4-Methylphenol	EPA 3546	EPA 8270D - PSEP	40
2,4-Dimethylphenol	EPA 3546	EPA 8270D SIM - PSEP	20
Pentachlorophenol	EPA 3546	EPA 8270D - PSEP	200
Benzyl alcohol	EPA 3546	EPA 8270D - PSEP	20
Benzoic acid	EPA 3546	EPA 8270D - PSEP	400

Note(s)

1. Reporting limit (RL) is defined as the lowest value at which quantitative detection of analyte is reported. RL assumes 100% solids.
2. Aroclors used in the calculation of Total PCBs will include Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260.
3. Puget Sound Dredged Disposal Analysis protocol for low detection limits.

Abbreviation(s)

CVAA = cold-vapor atomic absorption
EPA = U.S. Environmental Protection Agency
HPAH = high-molecular-weight polycyclic aromatic hydrocarbon
ICP-OES = inductively coupled plasma optical emission spectrophotometer
LPAH = low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg = milligrams per kilogram
PCBs = polychlorinated biphenyls
PSDDA = Puget Sound Dredged Disposal Analysis
PSEP = Puget Sound Estuary Program
RL = reporting limit
SIM = Selected Ion Monitoring
μg/kg = micrograms per kilogram

TABLE 2

ADDITIONAL CHEMICALS OF CONCERN, ANALYTICAL METHODS, AND REPORTING LIMITS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Sample Preparation/ Extraction	Analytical Method	Reporting Limit [1]
Conventionals			
Total Organic Carbon (Sediment)	—	EPA 9060	200 mg/kg
Total Solids	—	EPA 160.1	0.10%
Volatile Organic Compounds (µg/kg)			
Trichloroethene	EPA 5030B	EPA 8260C	1 µg/kg
Vinyl Chloride	EPA 5030B	EPA 8260C	1 µg/kg
Cis-1,2,-dichloroethene	EPA 5030B	EPA 8260C	1 µg/kg
Trans-1,2,-dichloroethene	EPA 5030B	EPA 8260C	1 µg/kg
1,1,-dichloroethene	EPA 5030B	EPA 8260C	1 µg/kg
Dioxins/Furans (ng/kg)			
2,3,7,8-TCDD	—	EPA 1613B	1.0 ng/kg
2,3,7,8-TCDF	—	EPA 1613B	1.0 ng/kg
1,2,3,7,8-PeCDD	—	EPA 1613B	5.0 ng/kg
1,2,3,7,8-PeCDF	—	EPA 1613B	5.0 ng/kg
2,3,4,7,8-PeCDF	—	EPA 1613B	5.0 ng/kg
1,2,3,4,7,8-HxCDD	—	EPA 1613B	5.0 ng/kg
1,2,3,6,7,8-HxCDD	—	EPA 1613B	5.0 ng/kg
1,2,3,7,8,9-HxCDD	—	EPA 1613B	5.0 ng/kg
1,2,3,4,7,8-HxCDF	—	EPA 1613B	5.0 ng/kg
1,2,3,6,7,8-HxCDF	—	EPA 1613B	5.0 ng/kg
1,2,3,7,8,9-HxCDF	—	EPA 1613B	5.0 ng/kg
2,3,4,6,7,8-HxCDF	—	EPA 1613B	5.0 ng/kg
1,2,3,4,6,7,8-HpCDD	—	EPA 1613B	5.0 ng/kg
1,2,3,4,6,7,8-HpCDF	—	EPA 1613B	5.0 ng/kg
1,2,3,4,7,8,9-HpCDF	—	EPA 1613B	5.0 ng/kg
OCDD	—	EPA 1613B	10 ng/kg
OCDF	—	EPA 1613B	10 ng/kg

Note(s)

1. Proposed reporting limit = practical quantitation limit.

Abbreviation(s)

EPA = U.S. Environmental Protection Agency
mg/kg = milligrams per kilogram
ng/kg = nanograms per kilogram
µg/kg = micrograms per kilogram

TABLE 3

SEDIMENT MANAGEMENT STANDARDS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Sediment Management Standards: SQS [1]	Sediment Management Standards: SQS Dry-Weight Equivalent [2]
Conventionals		
Total Organic Carbon (Sediment)	—	—
Total Solids	—	—
Metals (mg/kg)	**mg/kg dry wt**	**mg/kg dry wt**
Arsenic	57	57.0
Cadmium	5.1	5.1
Chromium	260	260
Copper	390	390
Lead	450	450.0
Mercury	0.41	0.41
Silver	6.1	6.1
Zinc	410	410
Nonionizable Organic Compounds	**mg/kg carbon**	**µg/kg dry wt**
Aromatic Hydrocarbons		
Total LPAH	370	5200
Naphthalene	99	2100
Acenaphthylene	66	1300
Acenaphthene	16	500
Fluorene	23	540
Phenanthrene	100	1500
Anthracene	220	960
2-Methylnaphthalene	38	670
Total HPAH	960	12000
Fluoranthene	160	1700
Pyrene	1000	2600
Benz[a]anthracene	110	1300
Chrysene	110	1400
Total benzofluoranthenes	230	3200
Benzo[a]pyrene	99	1600
Indeno[1,2,3-c,d]pyrene	34	600
Dibenzo[a,h]anthracene	12	230
Benzo[g,h,i]perylene	31	670
Chlorinated Benzenes		
1,2-Dichlorobenzene	2.3	35
1,4-Dichlorobenzene	3.1	110
1,2,4-Trichlorobenzene	0.81	31
Hexachlorobenzene	0.38	22
Phthalate Esters		
Dimethyl phthalate	53	71
Diethyl phthalate	61	200
Di-n-butyl phthalate	220	1400
Butyl benzyl phthalate	4.9	63
Bis[2-ethylhexyl]phthalate	47	1300
Di-n-octyl phthalate	58	6200

TABLE 3

SEDIMENT MANAGEMENT STANDARDS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Sediment Management Standards	
	SQS [1]	SQS Dry-Weight Equivalent [2]
Miscellaneous		
Dibenzofuran	15	540
Hexachlorobutadiene	3.9	11
N-nitrosodiphenylamine	11	28
Polychlorinated Biphenyls		
Total PCBs	12	130
Ionizable Organic Compounds	**µg/kg dry wt**	**µg/kg dry wt**
Phenol	420	420
2-Methylphenol	63	63
4-Methylphenol	670	670
2,4-Dimethylphenol	29	29
Pentachlorophenol	360	360
Benzyl alcohol	57	57
Benzoic acid	650	650

Note(s)

1. Sediment Management Standards Sediment Quality Standards 173-204-320 WAC.
2. SQS Dry-Weight Equivalent
   http://www.ecy.wa.gov/programs/tcp/smu/SQS_CSL_DW-ForWebsite.pdf

Abbreviation(s)

CSL = Cleanup Screening level
dry wt = dry weight
HPAH = high-molecular-weight polycyclic aromatic hydrocarbon
LPAH = low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg = milligrams per kilogram
PCBs = polychlorinated biphenyls
SQS = Sediment Quality Standards
µg/kg = micrograms per kilogram
WAC = Washington Administrative Code

TABLE 4

SUMMARY OF QUALITY OBJECTIVES FOR METHODS 6010/6020—ICP and ICPMS METALS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality-Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	Option 1: 1 std and blank, and a low-level-check standard at RL	Daily	Option 1: Low-level-check standard ± 1 RL
	Option 2: 3 stds and blank		Option 2: r > 0.995
Instrumental Precision	% RSD 3 integrations (exposures)	Each calibration and calibration verification standards (ICV/CCV)	% RSD < 5%
Initial Calibration Verification (ICV)	Midlevel (2nd source) verification	After initial calibration	% Recovery 90% to 110%
Initial Calibration Blank (ICB)	Interference-Free Matrix to assess analysis contamination	After initial calibration	Analytes < RL
Continuing Calibration Verification (CCV)	Midlevel verification	Every 10 samples and at end of analytical sequence	% Recovery 90% to 110%
Continuing Calibration Blank (CCB)	Interference-Free Matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < RL
Method Blank (MB)	Interference-Free Matrix to assess overall method contamination	1 per extraction batch of <20 samples	Analytes < RL and < 1/10th lowest sample instrument concentration
Laboratory Control Sample (LCS)	Interference-Free Matrix containing all target analytes	1 per extraction batch of <20 samples	% Recovery = 80% to 120% Sporadic Marginal Failures [1] % Recovery = 80% to 140%
Matrix Spike (MS)	Sample matrix spiked with all or a subset of target analytes prior to digestion	1 per 20 samples	% Recovery = 75% to 125%
Matrix Duplicate (MD) or Matrix-Spike Duplicate (MSD)	Refer to text for MD or MS	1 per 20 samples	RPD < 20%

Note(s)

1. The number of Sporadic Marginal Failure (SMF) allowances depend on the number of target analytes reported from the analysis. In the instance of only even metals, one SMF is allowed.

Abbreviation(s)

ICP = inductively coupled plasma
ICPMS = inductively coupled plasma mass spectrometry
RL = reporting limit
RPD = relative percent difference
RSD = relative standard deviation

TABLE 5

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 7000 SERIES—CVAA METALS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality-Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	3 stds and blank	Daily	r > 0.995
Instrumental Precision	RPD of 2 injections	All standards, and ICV/CCV	RPD < 10%
Initial Calibration Verification (ICV)	Midlevel (2nd source) verification	After initial calibration	% Recovery = 90% to 110%
Initial Calibration Blank (ICB)	Interference-Free Matrix to assess analysis contamination	After initial calibration	Analytes < RL
Continuing Calibration Blank (CCB)	Interference-Free Matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < RL
Continuing Calibration Verification (CCV)	Midlevel verification	Every 10 samples and at end of analytical sequence	% Recovery = 80% to 120%
Method Blank (MB)	Interference-Free Matrix to assess overall method contamination	1 per preparation batch of <20 samples	Analytes < RL
Laboratory Control Sample (LCS)	Interference-Free Matrix containing target analytes	1 per preparation batch of <20 samples	% Recovery = 80% to 120%
Matrix Spike (MS)	Sample matrix spiked with target analytes prior to digestion	1 per 20 samples	% Recovery = 80% to 120%
Matrix Duplicate (MD) or Matrix-Spike Duplicate (MSD)	Refer to text for MD or MS	1 per 20 samples	RPD <20%
Post-Digestion Spike (PDS)	Sample digestate spiked with target analytes	As needed to confirm matrix effects	% Recovery = 85% to 115%

Note(s)

1. The number of Sporadic Marginal Failure (SMF) allowances depend on the number of target analytes reported from the analysis. In the instance of only seven metals, one SMF is allowed.

Abbreviation(s)

CVAA = cold-vapor atomic absorption
RL = reporting limit
RPD = relative percent difference

TABLE 6

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 8270D—SVOCs FULL SCAN AND SIM

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality-Control Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	After CCV fails	r > 0.990 or RSD < 20% RRF >0.050 for SPCC and >0.010 for other cmpds
Continuing Calibration Verification (CCV)	At the beginning of each 12-hour shift	%D < 20% for CCC and < 40% for other cmpds RRF >0.050 for SPCC and >0.010 for other cmpds
Method Blank (MB)	1 per extraction batch of <20 samples	Analytes < RL
Laboratory Control Sample (LCS)	1 per extraction batch of <20 samples	Solids: % Recovery = 30% to 160%
Matrix Spike (MS)	1 per 20 samples	Solids: % Recovery = 30% to 160%
Matrix Duplicate (MD) or Matrix Spike Duplicate (MSD)	1 per 20 samples	RPD < 40%
Surrogates:	Every sample as specified	
Interference-Free Matrix		Interference-Free Matrix Solids: % Recovery = 30% to 160%
Project Sample Matrix		Project Sample Matrix % Recovery = 30% to 160%

Abbreviation(s)

CCC = calibration check compounds
cmpds = compounds
RL = reporting limit
RPD = relative percent difference
RSD = relative standard deviation
SIM = Selected Ion Monitoring
SPCC = system performance check compounds
SVOCs = semivolatile organic compounds

TABLE 7

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 8082—PCBs

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality-Control Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	After CCVs fail	RSD $\leq$ 20% or r $\geq$ 0.995
Continuing Calibration Verification (CCV)	At the beginning and end of analytical sequence, and every 12 hours	% Recovery = 75% to 125%
Method Blank (MB)	1 per extraction batch of ≤20 samples	Analytes < RL
Laboratory Control Sample (LCS)	1 per extraction batch of ≤20 samples	Solids: % Recovery = 37% to 116%
Matrix Spike (MS)	1 per 20 samples	% Recovery = 37% to 116%
Matrix Duplicate (MD) or Matrix-Spike Duplicate (MSD)	1 per 20 samples	RPD ≤ 50%
Regional Reference Material (RRM)	1 per 50 samples	Advisory Limits: Average +/- 2SD % Recovery 19% to 112%
Surrogates	Every sample as specified	% Recovery = 34% to 141%
Target Analyte Confirmation	Every detected compound	RPD $\leq$ 40%

Abbreviation(s)
- PCBs = polychlorinated biphenyls
- RL = reporting limit
- RPD = relative percent difference
- RSD = relative standard deviation
- SD = standard deviation

TABLE 8

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 8260C—SEDIMENT VOCs

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality-Control Element	Frequency of Implementation	Acceptance Criteria [1]
Initial Calibration	As needed	RSD $\leq$ 20%, $r^2 \geq 0.990$
Initial Calibration Verification (ICV)	After initial calibration	% Recovery = 70 - 130%
Continuing Calibration Verification (CCV)	Every 12 hours	% Drift $\leq$ 20%, %D $\leq$ 20%
Method Blank (MB)	1 per batch of ≤20 samples	Analytes < RL
Laboratory Control Sample (LCS)	1 per batch of ≤20 samples	Soil: % Recovery [2] = Vinyl Chloride: 53 - 120% Low Lev *Cis*-1, 2-Dichloroethene: 80 - 120% Trichloroethene: 80 - 120% Other analytes and Med Lev – various%
Matrix Spike (MS)	1 per 20 samples	% Recovery [2] = Vinyl Chloride: 50 - 150% *Cis*-1, 2-Dichloroethene: 60 - 136% Trichloroethene: 53 - 144% Other analytes – various%
Matrix-Spike Duplicate (MSD)	1 per 20 samples	RPD $\leq$ 30%
Surrogates: Interference-Free Matrix Project Sample Matrix	Every sample as specified	 Interference-Free Matrix Soil: % Recovery = Various% Project Sample Matrix % Recovery = Various%

Note(s)

1. Control limits, reporting limits, and method detection limits are subject to change based on annual verification and review by the analytical laboratory.
2. Control limits based on a 5-mL purge volume.

Abbreviation(s)

Lev = level
Med = medium
mL = milliliter
RL = reporting limit
RPD = relative percent difference
RSD = relative standard deviation
VOCs = volatile organic compounds
%D = percent difference

TABLE 9

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 1613B—DIOXINS/FURANS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality Control Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	Until CCV fails	m/z ratio within ± 15% of theoretical Signal/noise ratio ≥10:1 RR RSD ≤ 20% RRF RSD ≤ 35% RTs within windows GC resolution ≤ 25%
Mass Calibration and Mass Spectrometer Resolution	Beginning and end of each 12-hour shift	Resolving power ≥ 10,000
Window Defining Mix	Beginning of each 12-hour shift	RTs within windows
Continuing Calibration Verification (CCV)	Beginning of each 12-hour shift	m/z ratio within ± 15% of theoretical Signal/noise ratio ≥10:1 RR %D ≤ ± 20% RRF %D ≤ ± 35% RTs within windows
Method Blank (MB)	1 per extraction batch	Analytes < RL or < 5x Sample Conc.
Ongoing Precision and Recovery (OPR)	1 per sample batch	2,3,7,8-TCDD 67-158%
		2,3,7,8-TCDF 75-158%
		1,2,3,7,8-PeCDD 70–142%
		1,2,3,7,8-PeCDF 80-134%
		2,3,4,7,8-PeCDF 68-160%
		1,2,3,4,7,8-HxCDD 70-164%
		1,2,3,6,7,8-HxCDD 76-134%
		1,2,3,7,8,9-HxCDD 64-162%
		1,2,3,4,7,8-HxCDF 72-134%
		1,2,3,6,7,8-HxCDF 84-130%
		1,2,3,7,8,9-HxCDF 78-130%
		2,3,4,6,7,8-HxCDF 70–156%
		1,2,3,4,6,7,8-HpCDD 70–140%
		1,2,3,4,6,7,8-HpCDF 82-132%
		1,2,3,4,7,8,9-HpCDF 78-138%
		OCDD 78-144%
		OCDF 63-170 %

TABLE 9

SUMMARY OF QUALITY OBJECTIVES FOR METHOD 1613B—DIOXINS/FURANS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Quality Control Element	Frequency of Implementation	Acceptance Criteria
Labeled Compound Recoveries	Each sample and QC sample	13C12-2,3,7,8-TCDF 24-169%
		13C12-1,2,3,7,8-PeCDD 25-181%
		13C12-1,2,3,7,8-PeCDF 24-185%
		13C12-2,3,4,7,8-PeCDF 21-178%
		13C12-1,2,3,4,7,8-HxCDD 32-141%
		13C12-1,2,3,6,7,8,-HxCDD 28-130%
		13C12-1,2,3,4,7,8-HxCDF 26-152%
		13C12-1,2,3,6,7,8-HxCDF 26-123%
		13C12-1,2,3,7,8,9-HxCDF 29-147%
		13C12-2,3,4,6,7,8,-HxCDF 28-136%
		13C12-1,2,3,4,6,7,8-HpCDD 23-140%
		13C12-1,2,3,4,6,7,8-HpCDF 28-143%
		13C12-1,2,3,4,7,8,9-HpCDF 26-138%
		13C12-OCDD 17-157%
		37Cl4-2,3,7,8-TCDD 35-197%
		13C12-2,3,7,8-TCDD 25-164%

Abbreviation(s)
%D = percent difference
CCV = continuing calibration verification
GC = gas chromatography
MB = method blank
m/z = ion abundance
OPR = ongoing precision and recovery
QC = quality control
RR = relative response
RRF = relative response factor
RSD = relative standard deviation
RT = retention time

TABLE 10

DATA QUALIFIERS

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Qualifier	Description
U	The compound was analyzed for, but not detected.
UJ	The compound was analyzed for, but was not detected; the associated quantitation limit is an estimate because quality-control criteria were not met.
J	The analyte was positively identified, but the associated numerical value is an estimate quantity because quality-control criteria were not met or because concentrations reported are less than the quantitation limit or lowest calibration standard.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
NJ	The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents its approximate concentration.
R	Quality control indicates that data are unusable (compound may or may not be present). Reanalysis is necessary for verification.
UY	PCB Methods only. The laboratory uses the Y qualifier when interferences (usually the presence of the overlapping PCB Aroclor at high concentrations) cause the detection limit to be raised. The Y-flagged Aroclor may be present at concentrations at or below the limit reported, but in the opinion of the analyst, insufficient information is present to confirm the detection according to the method’s protocols. The concentration should be treated as a non-detected value at a raised detection limit. The “U” has been added to the lab’s “Y” qualifier to stress that the sample should be treated as a non-detected value.
EMPC	Dioxin/furan analysis only. Estimated Maximum Possible Concentration (EMPC) defined in EPA Statement of Work DLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmational ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria."
X	Dioxin/furan analysis only. Analyte signal includes interference from polychlorinated diphenyl ethers.
Z	Dioxin/furan analysis only. Analyte signal includes interference from the sample matrix or perfluorokerosene ions.

Abbreviation(s)
EPA = U.S. Environmental Protection Agency
PCBs = polychlorinated biphenyls

TABLE 11

CHEMICALS OF CONCERN FOR EACH MONITORING ACTIVITY

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

Analyte	Monitoring Activities			
	Pre- and Post-Construction Sediment Monitoring	Post-Construction Core Sampling	Post-Excavation Bank Sampling [1]	Post-Construction Surface Sediment Monitoring
Conventionals (TS and TOC)	X	X	X	X
Sediment Management Standards COCs				
Metals	X	X	X	X
Aromatic Hydrocarbons (LPAHs and HPAHs)				X
Chlorinated Benzenes				X
Phthalate Esters			X	X
Miscellaneous Extractables				X
Polychlorinated Biphenyls	X	X	X	X
Ionizable Organic Compounds				X
Non-SMS Analytes				
Dioxins/Furans				X
Volatile Organic Compounds			X	

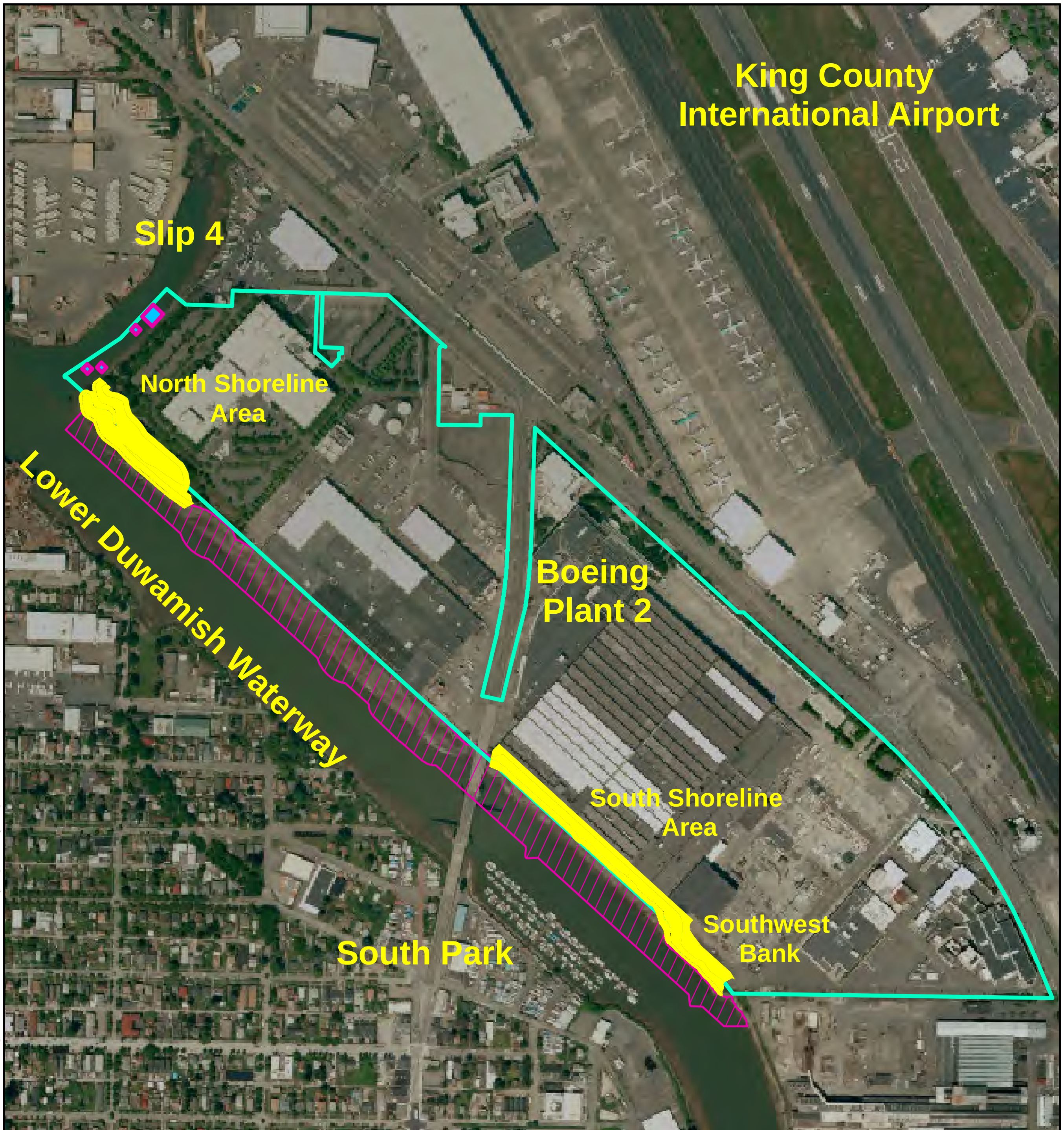
Note(s)

1. Not all analytes are analyzed at all locations. Detailed list of COCs by sample location provided in individual Work Plans.

Abbreviation(s)

COCs = chemical of concerns
HPAHs = high-molecular-weight polycyclic aromatic hydrocarbons
LPAHs = low-molecular-weight polycyclic aromatic hydrocarbons
SMS = Sediment Management Standards
TOC = total organic carbon
TS = total solids

FIGURES



Legend

Boeing Plant 2 Parcel

Shoreline Areas

In-water Dredging Areas

Duwamish Sediment Other Area

Slip 4 Dredge Areas

N

0 500 1,000
Feet

VICINITY MAP

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest
Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date:9/21/2012	Project No. 0131320070
		Figure 1

BOEING

File path: P:\BOEING\DESIGN\REPORTS\QAPP\QAPP and Monitoring Work Plans\QAPP|Figures|\Figure 1 Vicinity.mxd

Project Monitoring

Calendar Year	2012		2013												2014												2015					
Construction Phase		Season 2012/2013 Dec 1 through Mar 8			Shoreline Work No In-Water Work					In-Water Construction Aug 1 through Feb 15							Shoreline Work No In-Water Work					In-Water Construction Aug 1 through Feb 15							Shoreline Work			
Month	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Monitoring Activity																																
Pre-and Post-Construction Perimeter Sediment Monitoring		5 areas			4 areas				5 areas		4 areas						5 areas				4 areas								5 areas			
Post-Construction Core Sampling		3 locations as dredge areas accepted								11 locations as dredge areas accepted												1 location as dredge areas accepted										
Post-Excavation Bank Sampling							17 locations as excavation is completed																									

Post-Construction Surface Sediment Monitoring

Calendar Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Monitoring Activity		Year 0 (Marsh)		Year 0 (Remaining)	Year 1 (All Stations)		Year 3 (All Stations)		Year 5 (All Stations)		Year 7 (All Stations)			Year 10 (All Stations)
Post-Construction Surface Sediment Monitoring		6 Locations		30 Locations	36 Locations		36 Locations		36 Locations		36 Locations			36 Locations
	Project Construction Period													

Note:
Changes to the construction schedule and sequencing may modify the proposed monitoring schedule.
Additional monitoring may be conducted under the Pre- and Post-Construction Perimeter Sediment Monitoring to monitor potential impacts from other cleanup projects adjacent to Plant 2.

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TIMELINE OF PROPOSED MONITORING ACTIVITIES Construction and Post-Construction Sediment Monitoring Quality Assurance Project Plan Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project Boeing Plant 2 Seattle/Tukwila, Washington		
By: RHG	Date: 06/26/13	Project No. 0131320070
		Figure 2

Legend

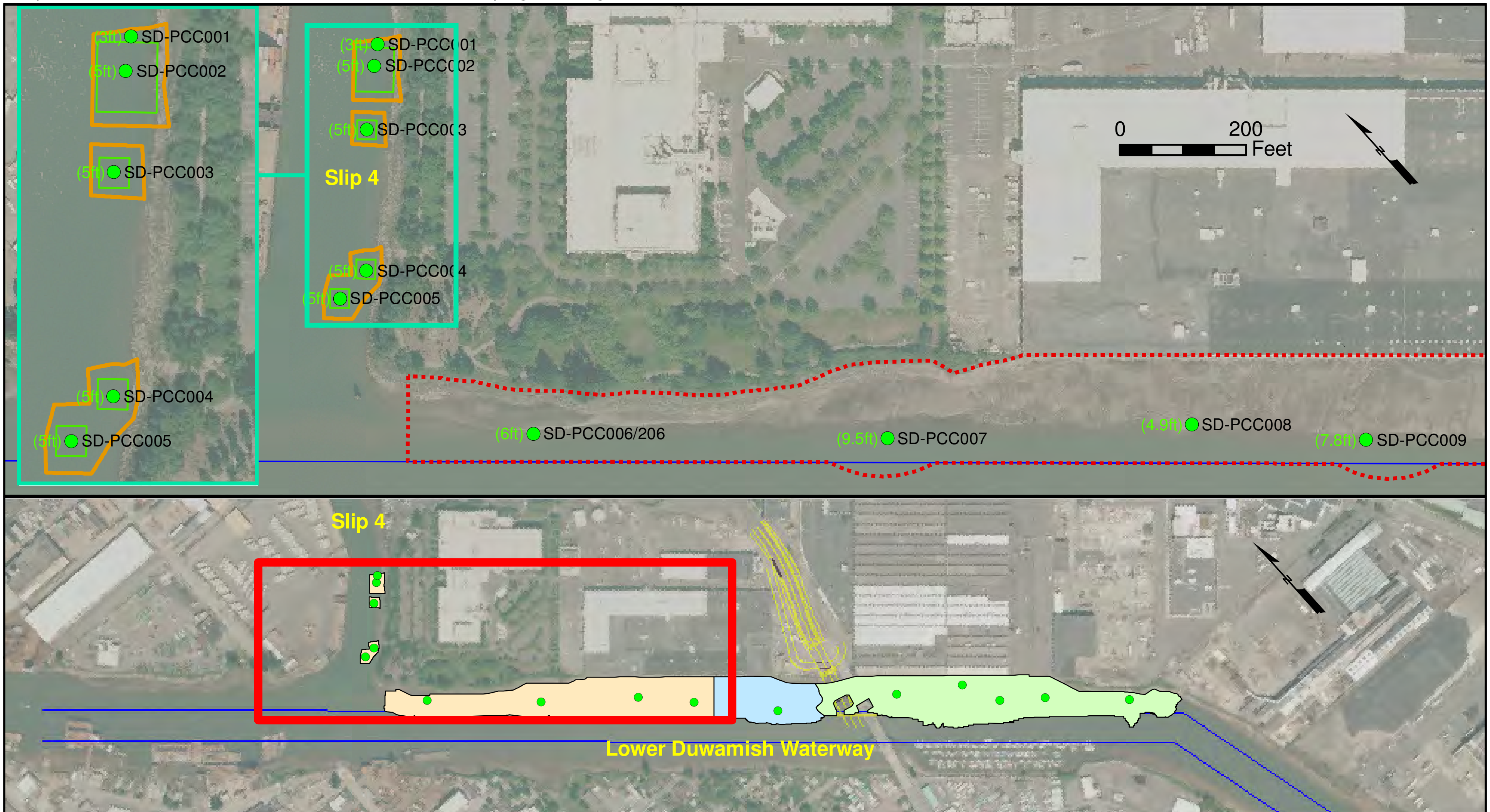
- 2012 - 2013 Construction Season
- 2013 - 2014 Construction Season
- 2014 - 2015 Construction Season
- Boeing Limits of Dredging
- Crowley Pier
- Jorgensen Cleanup Area
- Jorgensen Limits of Dredging
- T-117 Cleanup Area
- Perimeter Monitoring Areas
- Slip 4 Cap Area
- -4 ft MLLW Contour
- Navigation Channel Boundary
- Boeing Plant 2 Parcel

PRE- AND POST-CONSTRUCTION PERIMETER SEDIMENT MONITORING PROPOSED SAMPLE LOCATIONS
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date: 2/14/2013	Project No. 0131320080

Figure 3

File path: P:\BOEING\DESIGN\DATA\Post-Construction_Core Sampling\QAPP Figure 4.mxd



Legend

(4.9ft) SD-PCC004 Core Location (Proposed Dredge Cut)

Duwamish Sediment Other Area

Navigation Channel Boundary

Dredge Areas - Slip 4

Limits of Dredging - Slip 4

2012 Construction

2013 Construction

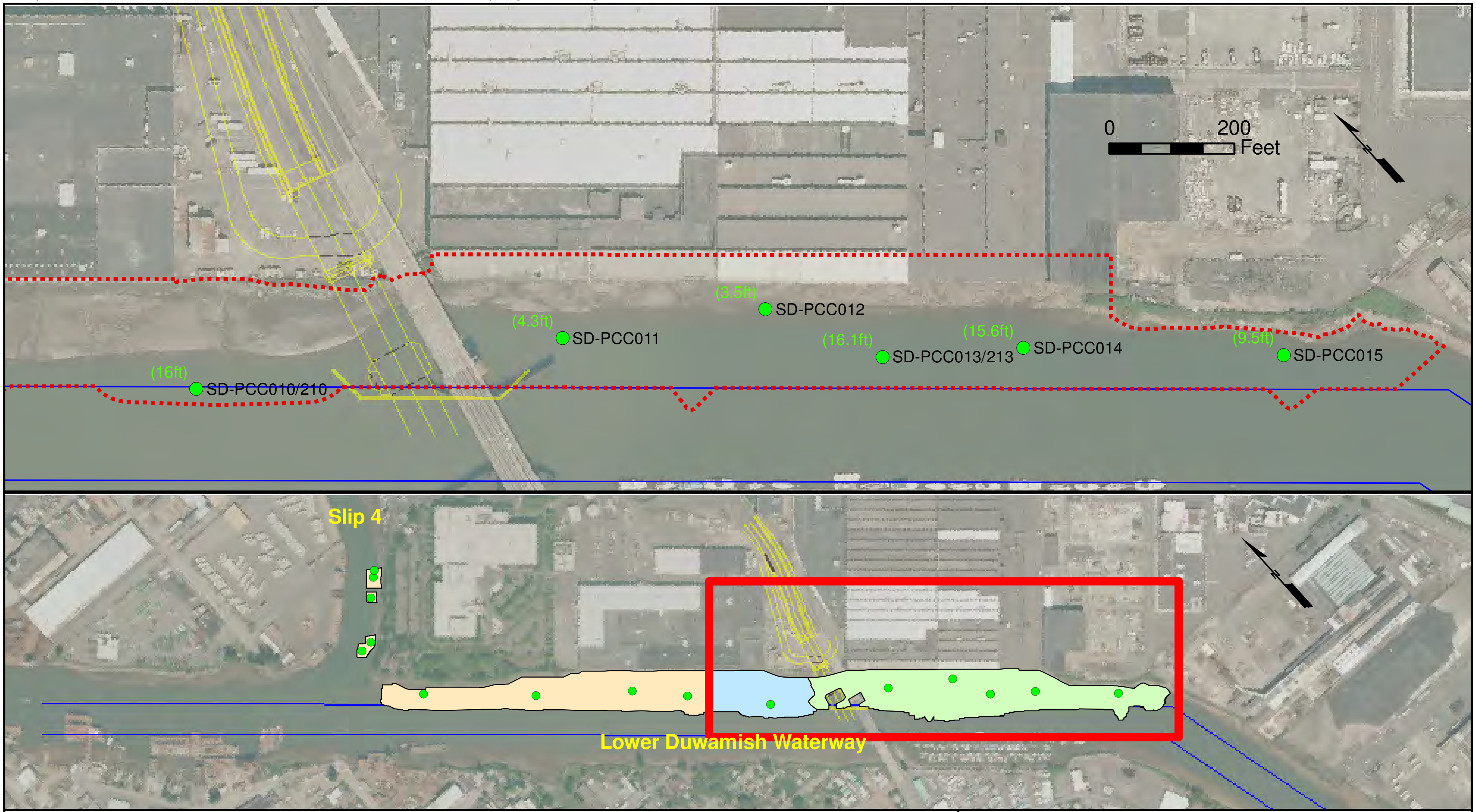
2014 Construction

BOEING

POST-CONSTRUCTION CORE SAMPLING PROPOSED SAMPLE LOCATIONS (NORTH AREA)
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date:2/26/2013	Project No. 0131320070
		Figure 4

File path: P:\BOEING\DESIGN\DATA\Post-Construction_Core Sampling\QAPP Figure 5.mxd



Legend

(4.9ft) SD-PCC004 — Core Location (Proposed Dredge Cut)

Duwamish Sediment Other Area

Navigation Channel Boundary

2012 Construction

2013 Construction

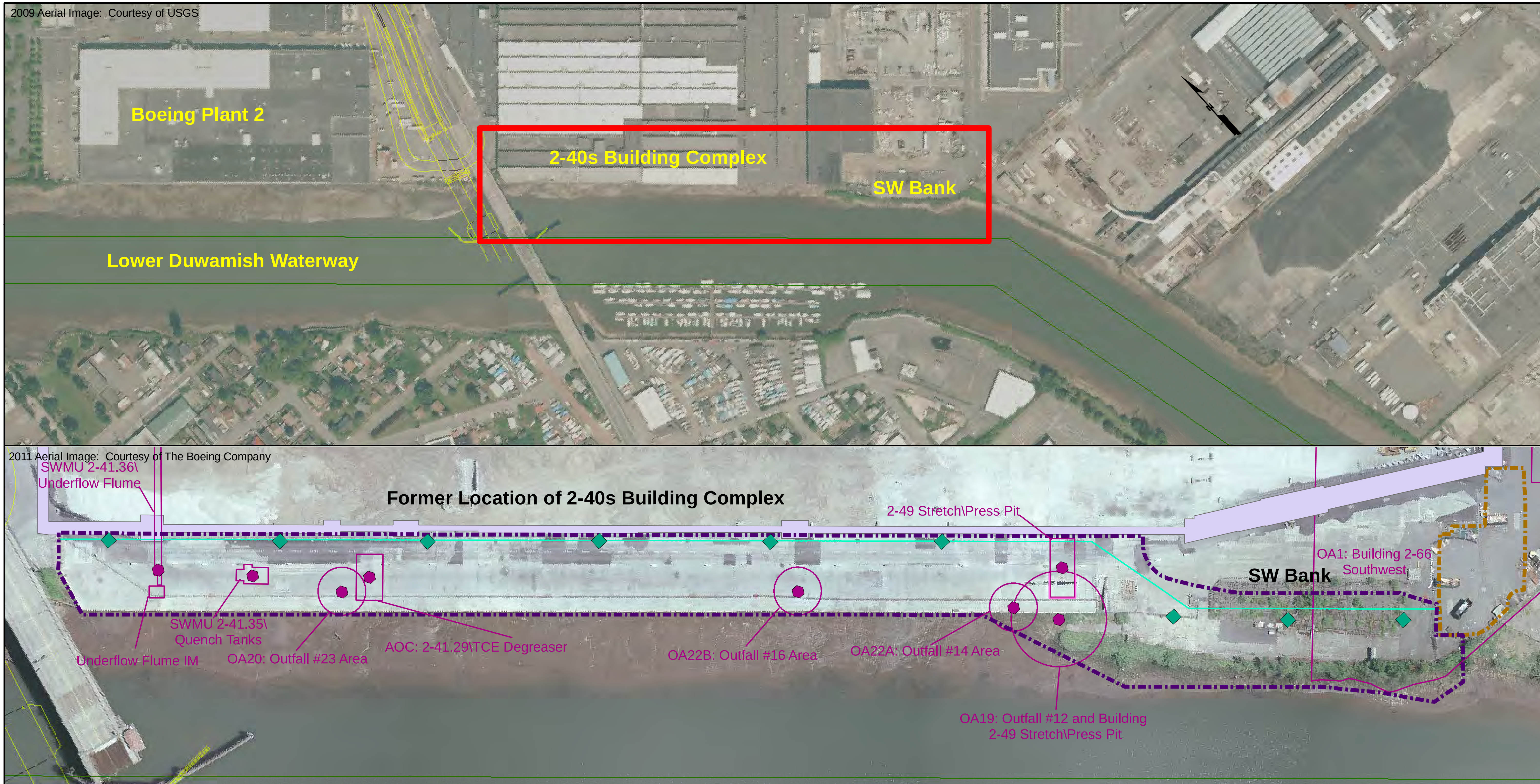
2014 Construction

BOEING

POST-CONSTRUCTION CORE SAMPLING PROPOSED SAMPLE LOCATIONS (SOUTH AREA)
Construction and Post-Construction Sediment Monitoring Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date:9/21/2012	Project No. 0131320070
		Figure 5

File path: P:\BOEING\DESIGN\DATA\Post-Excavation_Bank Samples\QAPP Figure 6.mxd



Legend

- Bank Samples
- RCRA Unit Record Samples
- +12 ft MLLW Post-Excavation Contour
- 2-66 Sheet Pile Containment Structure
- Shoreline Excavation Limit of Work
- Duct Bank Excavation
- Navigation Channel Boundary
- RCRA Units

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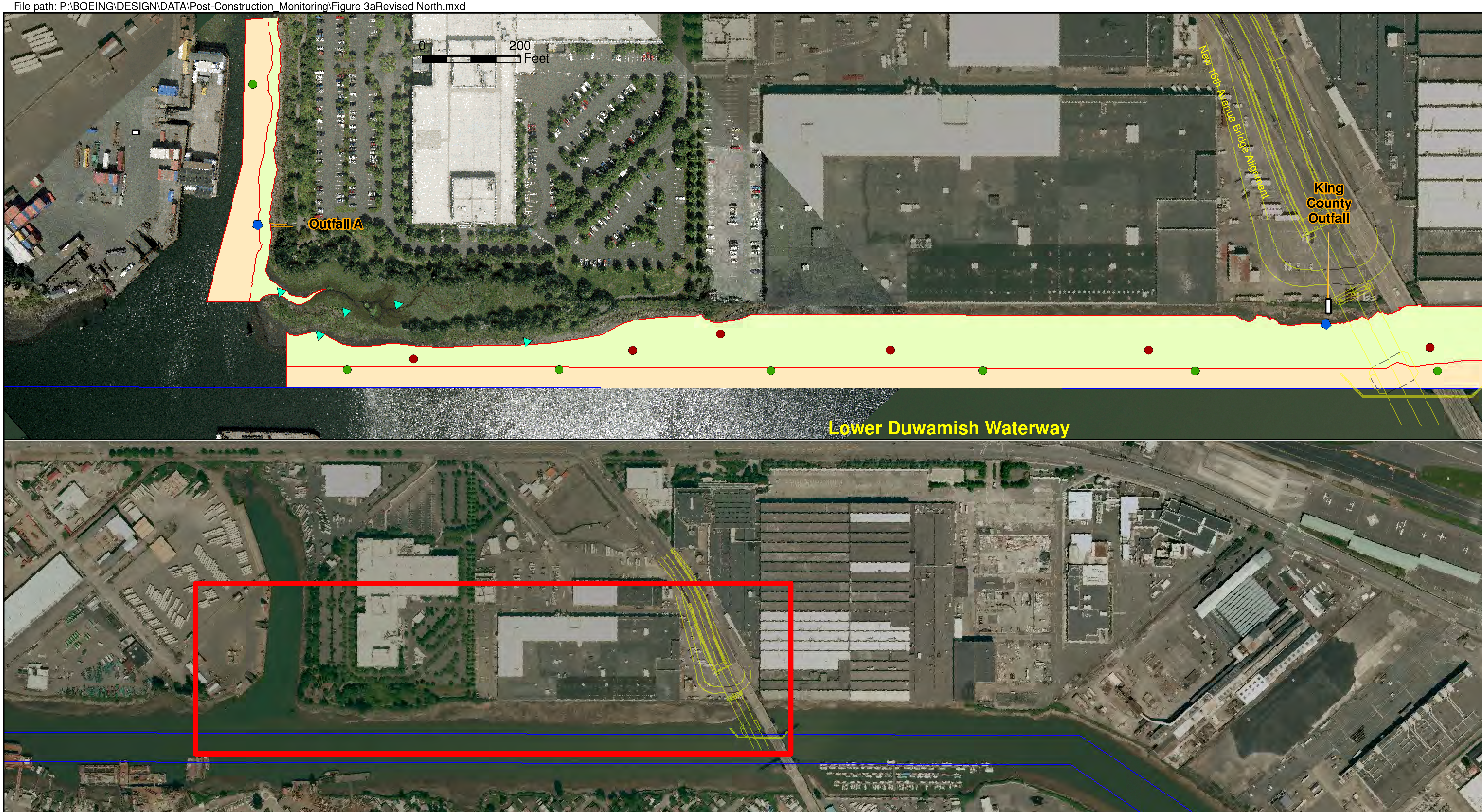
POST-EXCAVATION BANK SAMPLING PROPOSED SAMPLE LOCATIONS
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest
Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date:9/21/2012	Project No.0131320070
		Figure 6

File path: P:\BOEING\DESIGN\DATA\Post-Construction_Monitoring\Figure 3aRevised North.mxd



Legend

- Area Above -5 ft MLLW and Below +4 ft MLLW
- Area Below -5 ft MLLW
- Shoreline Area Samples
- Sampling Locations (Below -5 ft MLLW)
- Sampling Locations (Above -5 ft MLLW)
- Outfall Samples Locations

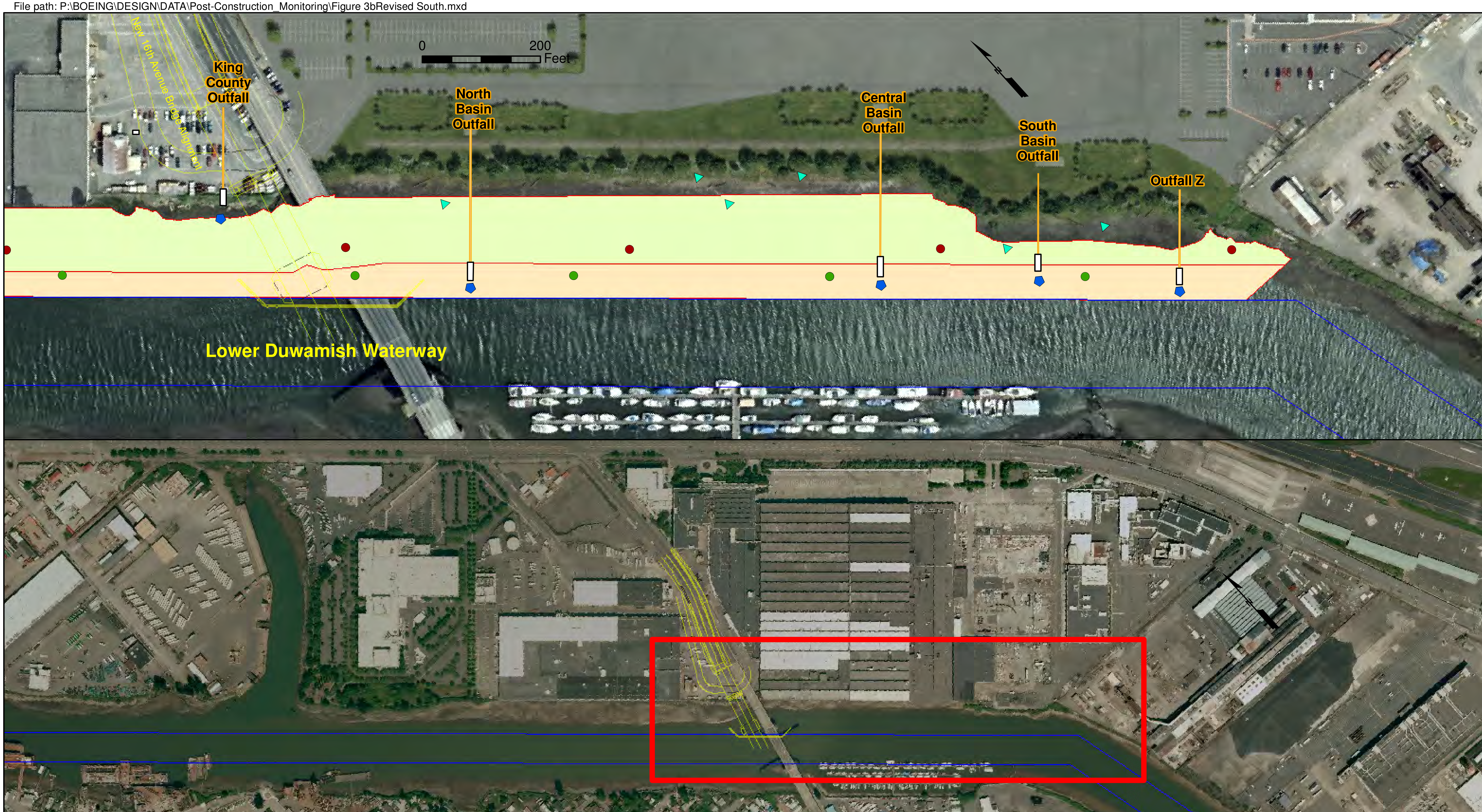
Notes:
Upper panel includes a artist rendition of the proposed North Shoreline habitat project.

BOEING

POST-CONSTRUCTION SURFACE SEDIMENT MONITORING
PROPOSED SAMPLE LOCATIONS (NORTH AREA)
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest
Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date: 5/31/2013	Project No. 0131320070
		Figure 7

File path: P:\BOEING\DESIGN\DATA\Post-Construction_Monitoring\Figure 3bRevised South.mxd



Legend

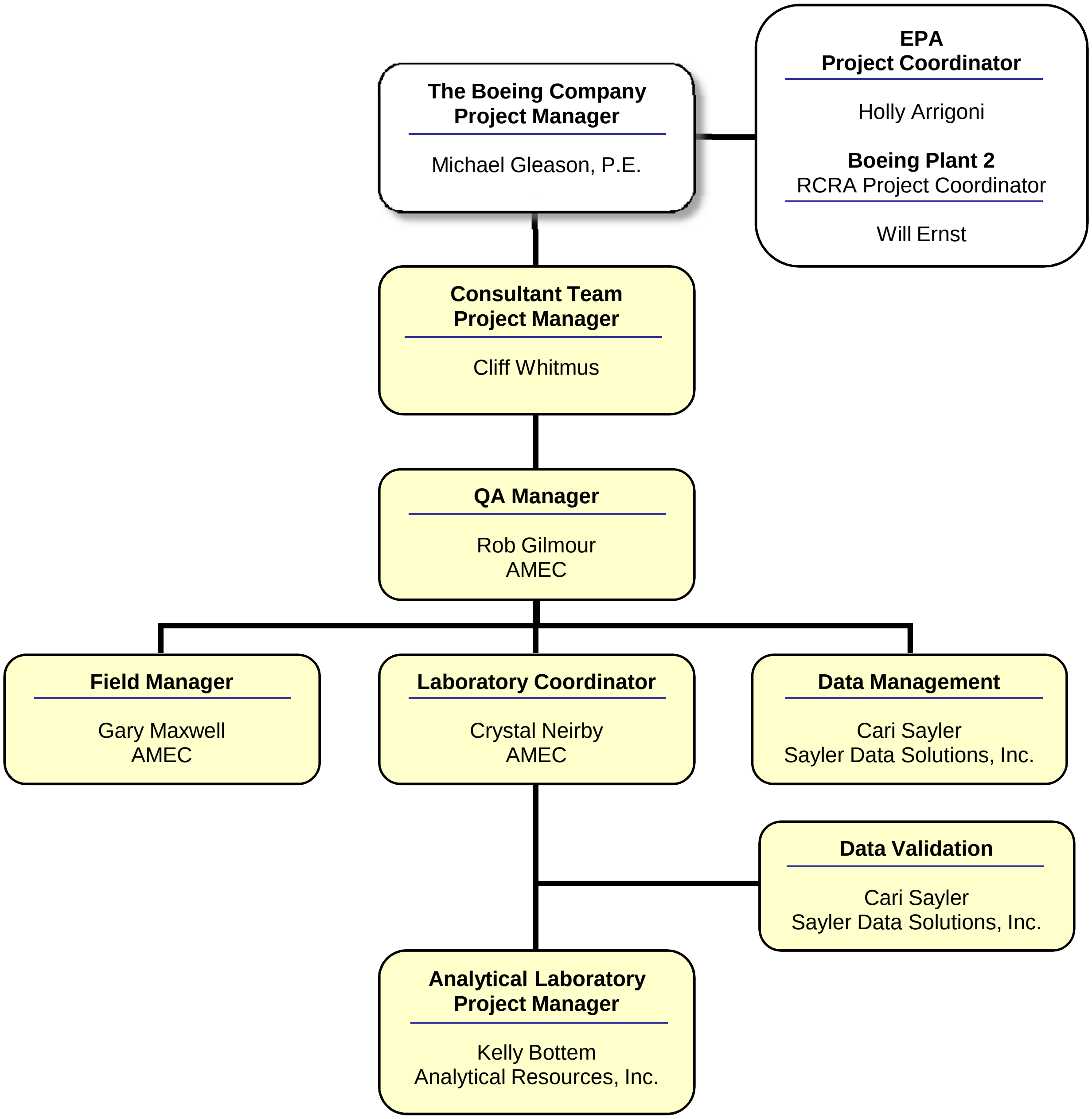
- Area Above -5 ft MLLW and Below +4 ft MLLW
- Area Below -5 ft MLLW
- Shoreline Area Samples
- Sampling Locations (Below -5 ft MLLW)
- Sampling Locations (Above -5 ft MLLW)
- Outfall Samples Locations

Notes:
Upper panel includes a artist rendition of the proposed South Shoreline habitat project.

BOEING

POST-CONSTRUCTION SURFACE SEDIMENT MONITORING
PROPOSED SAMPLE LOCATIONS (SOUTH AREA)
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest
Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date:05/31/2013	Project No. 0131320070
		Figure 8



PROJECT TEAM ORGANIZATION

Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank
Corrective Measure and Habitat Project
Boeing Plant 2
Seattle/Tukwila, Washington

By: RHG	Date: 08/13/12	Project No. 0131320070
		Figure 9

AMEC DGPS Check Form

Date: ____________

Project: Construction and Post-Construction Sediment Monitoring

Recorder: ____________

Calculated Location of Reference Station

Coordinate Datum: WA State Plane, NAD 83

Zone: North Zone

Reference Station Name: Check Point 1

Northing 196376

Easting 1274699

Units of Measure: Survey Feet

Reference Station Description: Piling at downstream end of the South Park Marina at the end of the channel side dock.

Start of Day

Time: ____________

Northing ____________

Coordinate Datum Setup Confirmed: ____________

Easting ____________

Comments: ____________

End of Day

Time: ____________

Northing ____________

Coordinate Datum Setup Confirmed: ____________

Easting ____________

Comments: ____________

Abbreviation(s)
DGPS = Differential Global Positioning System
NAD 83 = North American Datum 1983
WA SPC North NAD 83 = Washington State Plane Coordinate System, North Zone, referenced to the North American Datum 1983

BOEING

DGPS CHECK FORM
Construction and Post-Construction Sediment Monitoring
Quality Assurance Project Plan
Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project,
Boeing Plant 2, Seattle/Tukwila, Washington

By: RHG	Date: 08/13/12	Project No.: 0131320070
		Figure **10**

p:/boeing design/reports/qapp and monitoring work plans/figure 10.xlsw